Municipal and County Engineering

DESIGN, CONSTRUCTION, OPERATION AND MAINTENANCE OF ALL PUBLIC WORKS

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CONTENTS

Experience with Manager Government in Various Cities 255
Indianapolis Revolts 256
The Use of Calcium Chloride for Highways 257
Road Experiments by the University of Illinois 262
Super-Highways in Detroit Region 265
Highway Planning in California 268
Insuring Municipally Owned Property 270
Compacting Highway Fills by Jetting 272
The Contractor's Engineer 273
The Farmer and Federal Aid Highways 275
Difficult Foundations Constructed by Simple Methods 278
Reducing Infiltration into Sanitary Sewers 279
County Highway Officials Organize 281
Pension Systems for Municipalities 282
Aviation in America 284
New Legislation Affecting California Highways 291
Aircraft Resources of America 292
Flood Control 297
Minnesota Has Longest Concrete Road 304
Creamery Wastes 304
The Free Bridge 304

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PRACTICAL QUALIFYING OF BIDDERS ON PUBLIC WORKS

By Frank T. Sheets, Chief Highway Engineer, Illinois Division of Highways, Springfield, Ill.

(Paper read at 1927 meeting of American Road Builders Association.)

The protection of the public from the irresponsible contractor has become a problem of great importance. A survey of public works contracts executed throughout this country during the past ten years will show a long procession of disastrous failures of contractors. These failures have brought sorrow and suffering to the family and friends of the contractors themselves; they have cost the public millions of dollars in inconvenience and delay; and they have caused the bonding companies who have furnished bonds to suffer losses which have been automatically passed on to the entire construction industry.

An occasional failure is inevitable. Sudden changes in economic conditions, transportation facilities, or adverse physical conditions when combined with the inelasticity which surrounds necessarily all public work contracts may wreck an absolutely reliable, experienced, and financially capable contractor. However, the majority of contractors' failures have been directly traceable to inexperience, lack of funds, and lack of proper equipment. The novice in the construction industry and the reckless plunger must be saved from themselves and the public saved from them.

Irresponsible Bidder Costly

I have seen instances where an irresponsible bidder has been awarded contracts slightly under the figures of a responsible bidder and the resulting inconvenience and delay caused by his failure has cost the public a hundred times more than the difference in the bids. These conditions and these problems have become more and more pressing as the volume of public work has increased. It has been the custom for the surety bond companies, the material producers, the banks, and the contractors themselves to cry aloud in anguish over the lack of vision of the public official in awarding contracts to irresponsibles. At the same time, each of these agencies have perpetrated practices and policies which have made the path of the novice, the crook, and the plunger one of roses, and have forced the public official to stand the gaff of public criticism and even suspicion of his integrity if he were to carry out the dictates of his unbiased judgment in the elimination of irresponsible bidders.

What justification is there for the public official, who values his reputation and who has tried to build a record of square dealing, to jeopardize his reputation and his future by tackling single handed a problem which the construction industry at large yells about but leaves strictly alone? I declare that the public official as a whole has done more to stabilize the construction industry than the members of the industry themselves.

The Illinois System

In the Illinois Department of Public Works and Buildings, Division of Highways, we have faced this problem and have tried to meet it. Our laws require that our contracts be let to the lowest responsible bidder. We have realized fully that no arbitrary determination of the responsibility of a bidder could be made without suspicion of our motives. Therefore, some years ago we adopted a form of financial statement and experience and equipment questionnaire which we required each bidder to submit with his proposal for our consideration. We established, as a result of our own judgment and the judgment of a large number of reliable constructors, the minimum financial qualifications required for the execution of contracts of various sizes; we determined from years of experience the minimum requirements of equipment for various sizes of contracts; we analyzed carefully the prearranged plans for the contractor for handling every project; and with all this data for our guidance we have determined the responsibility of our bidders. Sometimes our judgment has erred, and an apparently responsible bidder has failed during the test of construction, but considering the fact that we have carried on over $150,000,000 worth of road contracts during the past few years since adopting this policy, the number of failures is gratifyingly small. We are still following this practice, and when we determine that a bidder is irresponsible, we write him a letter rejecting his bid and include in that letter a complete recitation of the facts upon which this judgment is based —these facts being taken from his sworn statement. We are willing to publish this letter to the world in case our motives are questioned or we are charged with favoritism, but we have not had to do so.

Making Responsible Contractors

In many instances when we have rejected a bid, we have suggested to the

bidder that although his qualifications were not sufficient to justify awarding the specific contract in question, further bids on smaller and less hazardous work would be welcome, and we have been pleased to see many such contractors develop to the point where they can now tackle most any project we submit.

The questionnaire which we are now using is the standard adopted by the American Association of State Highway Officials and embodies practically all of the features of our original questionnaire. The development of this questionnaire by the joint committees of public officials, contractors, bond writers, and other members of the highway industry has been a distinct contribution to the construction industry and I commend it most heartily for use by every public official. We have absolutely proved its value and would not be without it. It is interesting to note that in the awarding of the above mentioned large volume of contracts by our Department not a single suspicion of favoritism nor charge of wrong motive has arisen.

Embarrassing Situations

It is only fair to say, however, that sometimes the use of this questionnaire has caused us embarrassment in that we were forced to battle away at this problem alone when the course of least resistance would have been much more pleasant. Many times when the questionnaires submitted by bidders have shown them to be absolutely unqualified for the work they were seeking, we have had reputable surety companies state their willingness to write surety bonds for the bidders in question, and in some instances these companies have urged us to make such an award. It seems inconceivable that a bonding company would be willing to gamble their money on an irresponsible bidder unless the irresponsible is figured into their mortality rates; and if this is true, it is an unhealthy condition which is unfair to the responsible bidder.

Formerly this Department used to permit the submission of bidders' bonds instead of certified checks in connection with proposals in road lettings. Consistent securing of such bonds by irresponsible bidders led us to discontinue this practice and instead to require that certified checks amounting to ten per cent of the bid be submitted with all proposals. We were somewhat dumbfounded when we were informed reliably that representatives of surety companies had engaged in the practice of securing certified checks for bidders in order to get the jump on the bond business. It is apparent on the face of it that any bidder who cannot raise enough funds to secure a certified check deserves not only sympathy but also protection.

Bankers Too Liberal

It has also been a revelation to us how liberal the banking element of our citizenship has been in dealing with the irresponsible bidder. I sometimes feel that some of these bankers have made a bad loan to begin with and are still sending good money after bad in the hope that events will break in their favor. In some of our most questionable cases, banks have been willing to state that they were ready to extend a liberal line of credit to the bidder. I know of one instance where this was done and although the contractor executed an assignment of payment estimates to the bank, the bank neglected to file the assignment with our Department. After all payments had been made and the contract closed, the assignment was presented for our consideration with the result that the banker has gained some valuable experience in how "to hold the bag." If our bankers could be as "hard boiled" in such cases as seems to be customary with the average citizens, the construction industry would be better off.

How marvelous it is also that manufacturers of equipment and producers of material seem quite willing to extend the same business courtesy and line of credit to the "would be" contractor that they do a firm with millions of dollars of successfully completed work behind them and plenty of cash in the bank.

Allowance of Material Estimates

In order to minimize the interest charges necessary to complete State road contracts we have allowed payment estimates on materials delivered on the ground but not incorporated in the work. This policy has met with the enthusiastic approval of our most responsible contractors. Yet it seems strange that some of our contractors who are very weak financially have been able to buy materials without making assignments of these estimates and have then been able to use these estimates for current funds to finance labor and machinery payments while the material company blandly waited for the cash. Verily, verily, competition is keen.

The machinery companies have also been most sympathetic and brotherly in their treatment of the irresponsible contractor. I know of one instance where

the machinery was delivered on the job on a time payment basis. The contractor then went to the bank and borrowed money with which to run the job and put up the machinery as collateral to secure the funds. For ingenuity in financing, this is almost unexcelled.

Responsible Contractor to Blame

Enough for the activities of the irresponsible contractor and his generous associates. The responsible contractor is equally guilty in many instances. He goes right ahead buying his surety bonds, buying his machinery, and buying his equipment from the very parties who contribute to his unfair competition and then consoles himself by attending his annual contractor's meeting and singing a long lament about the bad conditions surrounding the contracting business. He comes to the desk of the public official with a complaint about the irresponsible bidder, and urges the former to wave the magic wand, administer poison or do some equally wonderful thing to remedy conditions. It is high time he called in force upon some of his other business associates and gave the public official a rest.

Fair Prices

We have insisted on absolutely fair prices for road work. This is evidenced by the general price reduction which was brought about some years ago after several months of controversy. When I say FAIR prices that is what I mean. We do not want contractors to do road work in Illinois and lose money, neither do we want them to make more than a fair profit. We have insisted on clean, keen, and open competition and our bids have proved that this exists. However, after some of our most experienced and strongest contractors have taken work at figures which are most gratifying to the State but which cause us to look with admiration and even wonder at the contractor in question, we have been somewhat astonished to have him explain that he took the work in order to keep his equipment busy. Yes indeed, depreciation is a wonderful thing, and occurs much more rapidly when the equipment is properly greased and stored than when subjected to the shock of operation and the grit or road grime!

Why fuss at public officials about the low prices at which the public work may be let when the most responsible men in the contracting business repeatedly establish such prices. Either the prices are right and the lament is wholesome propaganda, or the contracting industry needs to clean its own house.

No Numerical Limits

In this discussion I have not attempted to set up definite numerical limits nor mathematical formulae for establishing the responsibility of the bidder. I may have treated the subject from the prejudiced viewpoint of the public official, battling wearily with a seemingly endless problem; I may have cited certain horrible examples which are the exception rather than the rule; but if I have been able to stimulate the courage of the men in charge of public affairs; if I have been able to prick the conscience of the banker the machinery manufacturer, the material producer, the bond underwriter, and the responsible contractor; if I have been able to warn the embryo contractor that he must learn to walk before he can hope to run; then this paper will have served its purpose.

I congratulate the field that conditions are no worse. I declare that they can be made much better; and I urge all elements of the construction industry to proceed sanely, rationally and intelligently to a solution of this most important and perplexing problem.

SELECTION, USE AND CARE OF ROAD MAINTENANCE EQUIPMENT

By W. H. Root, Maintenance Engineer, Iowa State Highway Commission, Ames, Iowa

(Paper read at 1927 meeting of American Road Builders Association.)

The discussion of these problems in this paper will be confined to state equipment. The same general principles apply to county or township machinery, but not all of the detailed recommendations are applicable in the smaller units of government.

The selection of maintenance equipment is a twofold problem. (1) The type of equipment must be determined, and (2) the particular make must be chosen. The general maintenance problem of every state is to maintain its state system satisfactorily at a minimum cost. This cardinal principle should always be kept in mind when equipment is being purchased or used. When in the development of your maintenance plans it is apparent that new machinery is needed, you should first make a careful study of the future development of the road upon which the equipment is to be used. Otherwise, you may have very satisfactory results for a year or two, and then find yourself with an expensive white ele-

phant on your hands. You should also be sure that the type selected will fit in with the other equipment already on hand in that particular maintenance unit. In other words, cooperation of equipment as well as cooperation of men is essential.

Selection of Equipment

In choosing an equipment type, the most important consideration is that the equipment selected must do the job that you have for it, and that it must continue to do this job over a reasonable period of years. I mean by that that the type must be proven. A particular type machine has not established its right to serious consideration until it has been operated under typical conditions for a year or more. Do not construe from this that the purchase of new designs is undesirable. Every state should buy new developments of machinery adapted to their work, but such purchases should be limited to a few experimental outfits until the machine has proven itself. Personally, I do not look with favor upon so-called demonstrations. I never yet saw a machine fall down on a demonstration. A clever operator and a wisely selected road will put over any machine for a few days or weeks.

When you have determined the type of machine best adapted to your work, your problem is only half solved. Whose machine are you going to buy? Don't let the salesman do all the talking. Ask a few questions yourself. Don't allow yourself to be sold by a salesman, but rather be sure you are sold on the machine.

It isn't necessary that you buy the lowest priced machine, but you should be sure that the machine you buy is not overpriced. Some machines are priced for trade-ins. This fact is not hard to determine, and if you find it to be the case, don't pay cash at trade-in prices. You should also look into the matter of parts, prices and service. Any machine will require new parts occasionally, and these should be furnished at a reasonable price, and they must be furnished promptly. Delays due to poor service on repair parts are expensive.

Power an Important Factor

Also look to the power of any equipment you are considering. Horse power ratings are not always reliable and an under-powered machine is a constant expense and irritation. The fuel cost is another item which should be investigated. It is not enough that the machine do the work required of it, but it should do this work at an economical operating cost.

Then last but not least, in determining the dealer from whom you will make your purchase, keep in mind that it is always desirable to deal with a well established firm. Our junk yards are full of useless orphaned machines. The amount of money represented by this junk is a tremendous sum, and in my mind is one of the few public road expenditures which is open to criticism. In this day of rapidly changing conditions and methods, it is a problem for any machine company to keep its equipment abreast of the times. Machines are continually developing weaknesses, and proving uneqal to the constantly increasing tasks to which they are put. These so-called "bugs" require study and adjustment. If when a machine is sold, the seller considers the deal closed, that machine is an undesirable purchase. Be sure the company you deal with is one that takes an interest in its sales, not only until your name is signed on the dotted line, but continuously thereafter through the entire life of the machine.

Care of Equipment

For the purpose of this paper it is not necessary to enter into any extensive discussion of the use of maintenance equipment. This subject in itself might readily be expanded to cover the whole field of road maintenance. In this connection, I simply wish to say that maintenance equipment should be used often and should be used hard. However, it should not be abused. Use a machine for what it is designed plus a reasonable overload. This word "designed" is used advisedly. Some machines are designed to do certain work, while others are manufactured to sell. If you are a good buyer you will not have on hand any machines of the latter class.

All maintenance equipment should be properly cared for. If you will recall how you mothered your first Ford for a month or two after its purchase you will have an idea of how you should treat your road machinery, but this careful attention should not be allowed to lapse as soon as the paint wears off. Road maintenance equipment should be kept painted. This not only preserves the equipment against the weather, but it has a good psychological effect on the operator and upon the public. An operator is less apt to abuse a well painted machine than he is a rusty, weather-beaten one. Also the public will judge you somewhat by the appearance of your equipment. If you keep your machinery painted bright and clean the public will

feel that you are endeavoring to conserve the road funds that they have supplied to you. On the other hand, if your equipment appears run down and uncared for, the public may get the impression that, if you are careless in these little matters, that you may also be careless in the larger matters of highway finance.

Inspection and Housing

All maintenance machinery should be gone over every few days and loose nuts, joints and bearings made tight. Rainy days when the equipment cannot be operated are ideal times for this kind of work. As to the housing of equipment, most machines should be stored inside in order to protect them from the elements and from the light fingered public. Road economists have figured that the depreciation (due to weather) on certain types of equipment is less than the interest and depreciation for housing facilities, and they, therefore, maintain that such equipment should simply be kept painted and stored in the open. Be that as it may, there is still the matter of public psychology to deal with, and for my part, I would prefer to house the equipment rather than be censured for an apparent neglect.

Lubrication

Without doubt, the most important consideration in the care of maintenance equipment is lubrication. I do not know of any modern road equipment that does not require some sort of lubrication, and on some of the more complicated types an hour of greasing and oiling each morning is a necessity. If we had perfect lubrication we would have no wear, and, barring breakage, theoretically our machines would last forever. The nearer we come to this ideal, the longer our equipment will last, and the most reasonable will be our maintenance costs.

In conclusion then, I would sum up the paramount points to be considered in selection, use and care of maintenance equipment as follows:

(1) Buy a proven machine from a reliable established dealer.
(2) Use it but do not abuse it.
(3) Keep it lubricated.

STATE VS. CONTRACTORS CONTROL OF MATERIAL

By A. F. Johnson, Contractor, Minneapolis, Minn.

(Paper read at 1927 meeting of American Road Builders Association.)

The control of material must necessitate the purchase of material. In general no state has entered into the purchase of material for construction purposes, excepting in highway construction, and so the writer will limit this discussion to material used in highway construction.

The advent of any state into purchasing of material is of recent date, commencing about 1921, and was brought on by the tremendous increase in demand for hard surfaced roads in 1920. This necessitated a big increase in material needed and the existing producers in many cases were not equipped to take care of this large demand for their product. An unusual shipping situation also developed in 1920 and the construction program was slowed down.

The two main reasons that induced some states to purchase material at that time were: 1. To insure sufficient supply of material. 2. To reduce the cost of such material. These same reasons are today the governing factors when a state considers the purchase of material, especially cement, for its highway work, Therefore, this paper will be devoted mainly to a study of these two factors. An argument has been advanced for states purchasing cement that they would then get a better quality of cement and be assured that the right amount of cement was used. With the inspection and supervision that all states have on road work, there can be no question of quality or quantity whoever furnishes it.

Construction By The State

To insure greater production and lower costs some states did help finance aggregate producers. One state in order to increase its pavement mileage even went into the construction of roads itself, with disastrous results. To insure a supply of cement and save money, several states bought their cement direct and stored a certain portion for each contract. One state furnished the cement, rock and sand on its work during such a time of material shortage as we had in 1920 and found that it was not helping the situation by its control of material, but was thereby causing friction between its engineering department and the contractor, and was confronted with claims filed by the contractor for losses due to non-delivery. That state has gone out of the material business entirely. The writer questions very much that the result would have been any better, if the states had controlled the material during 1920; most likely it would have been worse.

There is at present and will be in the future a sufficient supply of material for road construction and we should not have

another 1920. The price has been decreasing irrespective of who furnished the material. This sufficient supply of material has been brought about by the law of supply and demand and not as a result of any state purchasing material direct. Our road program has become stabilized and material requirements are known nearly a year ahead of time.

The writer feels certain that no state is at present contemplating purchasing or controlling aggregate. That contractors can purchase these just as cheap or cheaper than a state is a well conceded fact. This applies also to other material, such as steel, piling, lumber, etc. The cement is the largest single item of material used on road work, therefore, the question of the purchase and control of cement is what we are mostly concerned over.

Purchase for Bridges

For State Highway work, cement is used mainly in pavements and bridges. One state purchases the cement for bridges as well as pavement. Assuming that the state does not save the cash discount and the dealer's differential, the writer feels that on work as small as most highway bridges are, requiring only small lots of cement at a time, that if the contractor could purchase his cement from a local dealer, that the value he would receive in using the dealer's storage shed and possibly the dealer doing his hauling, would more than compensate for any saving made by the state in purchasing this cement. The purchase of cement for pavement is therefore the main point of contention.

There are three parties concerned in the control of cement for highway work; the cement company, the state and the contractor. It is quite obvious that a cement company that can sell a large volume to the state at one sale will cut down its selling costs over selling that same amount to a number of different contractors. That cement company would also know at the beginning of the year, its quota of road cement and govern its output accordingly. The writer is inclined to feel however, that the small producers would be discriminated against in that the state purchase would most likely be from the large producer, the price of course being the same.

By the state purchasing the cement, what competition there should be is entirely destroyed. In one nearby state, which did not purchase its own cement last year, there developed quite a cement war between dealers and even between producers and the price of cement was cut considerably. The writer doubts that this would have occurred if the state had purchased the cement and surely there would have been no reduction in the price of the cement to the state.

Supply of Stocks

The question of supply of stocks of cement by companies in general would be no different if the state purchased the cement in January, or if it was left to be purchased by the contractor later in the season. The cement industry is a well-organized business and they take notice of ,and provide for the requirements of the State Highway work, whether it is purchased at once or during the season. The contemplated program in any state will be known even before the state can purchase the cement required. That the state is assured of a better supply by storing cement on each job goes without question. This, however, is not done before a contract is let to a contractor and assuredly the contractor can store his own cement just as easily as he can store the state's cement. Furthermore, the state can insist that the contractor purchase at once and store whatever portion of the cement they deem fit.

Now, let us see what saving, if any, a state does make by purchasing its own cement. The states purchasing cement do so generally in January and February. During the last four years, there has been in general a fluctuation of 10c a barrel in the price of cement, the low price occurring in the fall of the year and the advance taking place in January and extending until about October. Last year there was no change in the price of cement. States that have purchased their cement have done so generally in January or February and it is quite evident that they have been paying the high price. Furthermore, if these states were to buy their cement in the fall of the year for the next year's requirements, then no doubt the price of the cement would be advanced at that time rather than in January.

No Dealer's Differential

When the state purchases cement it does not pay the dealer's differential of 10c, which some have considered a saving for the state. The writer questions very much that except in isolated cases, a contractor on paving work does pay the dealer even as much as 5c per barrel differential. In the writer's experience over the past three years and working in two states, 1c per barrel would be a fair average of what he has paid and

what other contractors to his knowledge have paid on this dealer's differential. There are, however, concessions made to contractors when they are in the market for the purchase of cement themselves, that the writer feels will overcome any saving in dealer's differential made by the state purchasing this cement direct. There are generally accommodations to be had from the local dealer and also when the contractor has the routing of the cement to make, he will generally get concessions from the local railroad companies on sidings, service, etc., by giving them the haul. He furthermore has a better control of his sack loss which in some cases has been large when the state has furnished the cement, in which case the contractor has little if any recourse for adjustment of this loss.

All states, no doubt, would take their 10c per barrel discount on their purchase of cement. A responsible contractor does the same, and if he is not able to take his cement discount he should not be in the business of highway construction. It is the writer's opinion that where the contractor furnishes his own cement that the contractor figures in his cost the net price of cement, that is, with the discount and cost of sacks taken off.

Financing the Purchase

It is quite evident that whoever purchases the cement has to finance same and this must be of some cost to the State and also more clerical work and responsibility falls upon the State Highway Department when they handle the purchase of any material direct. With the addition of this cost to the state, the writer feels that there can be very little, if any, saving in the cost of the cement to the state by its own purchase.

If a state was to take two bids on a project at the same time, one where it purchased the cement and the other where the contractor furnished the cement, either bid from a responsible contractor should bring about the same cost to the state. This last year, one state took bids on one job with the state furnishing cement and later on took bids on the same job with the contractors furnishing the cement, with the result that they awarded the job, with the contractor furnishing the cement at a saving of $1,500.

There is, however, a saving in the amount of the bond premium by omitting the cement from the general contract. This saving will amount to about $100 per mile. By reducing the amount of money involved the state is, however, inviting a lower standard of qualification, which must mean more irresponsible contractors. There surely are plenty of competitors in highway construction without lowering the skill, responsibility and general standing of such competitors. There are, no doubt, enough responsible contractors in the field today to pave twice the mileage contemplated for this year. Furthermore, if we should have a shortage of material like we had in 1920, the state will lay itself open to claims for loss of time, etc., due to non-delivery of any material that the state is furnishing.

Effect on Bids

Let us see how the question of cement purchase affects the contractor's bid in figuring on such work. If the cement is furnished by himself, he will add to his cost an additional premium of about $100 per mile for the contract bond. He will also have to use additional finances to carry through the purchase of cement. This is no burden to a responsible contractor, but as a business proposition the extra money involved should be figured with interest at 5 per cent. This rate of interest to take care of handling the cost of sacks, discount and the 15 per cent carrying charge on the work done would amount to about $35 per mile of pavement, estimating that each mile of pavement will require about 3,200 barrels of cement. He has, however, complete control of his materials. He will figure in his cost, the gross cost of cement to the dealer, plus a small allowance for the dealer's differential, less the cost of the empty sacks and less the discount. His purchasing department is already organized to take care of the purchase and handling of this and any other material and so this would involve no extra cost to him. He is, himself, responsible for the delivery of this material and in case of shortage and non-delivery, he will not be able to file claims against the state for such non-delivery. In furnishing his own cement he is in an advantageous position with railroad companies, as stated before, and he gains both present and future advantages in dealing with certain cement companies and dealers and thus establishes good business relations.

If the state furnishes cement, his bid will be reduced by this net cost of the cement and also by about $135 per mile for smaller bond premium and less carrying charge for financing. He will have to add to this the extra money it will cost on a possible large empty sack loss, loss of advantages he would otherwise have

in dealing with railroad companies, concessions that he might get from good cement company connections, either on this work or future work, and by decrease in his purchasing power and loss of initiative.

It is quite evident that the contractor's profit should be the same, whether he or the state furnishes the material. His costs will be different in the two cases, but his actual organization, equipment, work and risk will be the same; therefore, surely he is entitled to, and his profit should be, the same in either case.

Contractor's Preference

In conclusion, a responsible contractor prefers to purchase and control all materials entering into his construction work. He serves the purpose of furnishing:

1. Equipment and organization.
2. Necessary finances.
3. Purchasing power for material and labor.
4. Responsibility for the prosecution and completion of the work involved.

For any and all of these, he will function better and more economically than any other agency. A state purchasing material does not avail itself of the purchasing power of the contractor and tends to destroy his initiative and this without any apparent gain. A state purchasing material means government in business. This has proved uneconomical, as we know, and is contrary to the policy of the present administration and the Government at large.

CONTROL OF CONSTRUCTION UNIT COSTS THROUGH DESIGN

By T. Warren Allen, Chief, Division of Control, U. S. Bureau of Public Roads, Washington, D. C.

(Paper read at 1927 meeting of American Road Builders Association.)

The tremendous annual expenditure in the United States for highway improvement, amounting to a little over a billion dollars a year for rural highways or approximately a billion and a half, including city streets, is ample warrant for intensive studies undertaken for the purpose of promoting greater efficiency and securing a greater amount of work for the expenditures made. Lines of such study which may be pursued with profit are location, design, and the management of construction; location, for the purpose of securing the shortest and best lines to serve a given section; design, to secure the best and most economical plan along this location on which to secure bids from contractors; and, third, the management of construction.

The proper location, design, construction and maintenance of highways are also far-reaching in importance, not only to the traveling public when considered from the vehicle operating standpoint, but, to communities, large and small, when considered from the standpoint of development, comfort and advancement. The purpose of this paper, however, is to discuss one phase of design that affects construction costs and these other allied subjects are referred to so that a vision may be had of the wider field highway engineers must occupy.

Cutting the Mixing Time

In highway design more or less consideration is given to keeping down excavation quantities, but the problem is usually not given the consideration it warrants and the result is but a partial solution. It is not the purpose of this paper, however, to dwell upon this phase of design or the adverse effect on cost of poorly written specifications and unduly drastic inspection. One specification item, that of mixing time, may be mentioned. Some engineers specify one and a half minutes for mixing time of concrete, while others specify one minute, but a considerable number of field tests indicate that with the better designed mixers and adequate control over materials and water content, three-quarters of a minute of mixing will give a concrete of so nearly the same strength as a minute or a minute and a half that the extra cost of the longer mixing time does not seem warranted. Cutting the mixing time by this amount and keeping the mixer fully occupied are very important items in a cost reduction program. This may be more definitely expressed by stating that the maximum number of batches of concrete that may be turned out per hour with a mixing time of 1½ minutes is 34, for one minute 48, and for three-quarters of a minute 63, and that for a full working day of 10 hours the cost of paving is increased about $400 per mile of pavement laid for each one-fourth minute added to the mixing time. Unless recently changed, nine States require a 1½ minute mix, six a 1¼ minute mix, and thirty-three a minute mix. Also, there is the item of time specified for curing. With adequate control this time, except at the beginning and at the end of the construction season, may be cut at least to 14 days. Eight states now require 30

days before the pavement may be opened to traffic, one state 28 days, twenty-nine states 21 days, four require 20 days, one 18 days, three 14 days, and two 13 days.

More Attention for Pavement Loads

Again, the items of proportioning and time of mixing are determined without giving much attention to the strength of the concrete needed to withstand the loads to come upon the pavement. The highway engineer should take cognizance of these and similar things, and constantly study the activities in which he is engaged for the purpose of discovering how they may be brought to a more efficient state, and take steps to introduce the necessary betterments. I believe that a more aggressive attack on the important problems confronting the highway engineer will also do a great deal towards enhancing his professional standing.

Let us now give consideration to another effect of design on construction costs, that of haul length. This is a matter of importance to all sorts of construction, but it seems to be of greater immediate moment in the grading field than in other phases of highway work. The first thing that strikes one in any extended study of the salient features of grading work is that it divides naturally into two distinct categories. There are, first, digging and loading, and, second, transporting. It is not of interest here to trace the line of demarkation down through such tools as the fresno and the wheel-scraper, though this can be done readily enough on a perfectly rational basis. Rather, in developing the effect of design on cost, it is better to take an equipment set-up where the demarkation is clear, as in the case of the elevating grader or the power shovel on the one hand and the teams and wagons on the other.

Costs Little More to Double Production

A power shovel requires a given crew for its proper operation, no matter what output is being secured. Depreciation is not much affected by the amount of material handled during any given time. Even the amount of fuel used falls only slightly as the rate of production drops. The same condition is to be observed in the operation of a concrete mixer. The one man who runs the mixer cannot be cut to half a man if a batch is run out every 2½ minutes instead of every 1¼ minutes. The mixer runs along at a steady pace whether batches are put through it at the proper rate or not, so wear and tear are little affected by the utilization made of its working time. Perhaps a little less fuel is burned when the drum runs light, but the difference is slight.

These illustrations could be multiplied but to do so would be merely to add emphasis unnecessarily to the fact that in the highway field each piece of equipment generates an operating cost which is pretty constant, so much so in fact, that if a contractor sends out a power shovel or a mixer or an elevating grader or even a plow or a fresno, he has for the job to which this equipment is sent added a fixed item of daily expense that is just about as constant and just about as rigid as the employment of another laborer at fixed wage per day. The contractor can discharge the laborer, but while he is on the job he will draw his wage every day he works. The contractor can also discontinue the use of the shovel but as long as it is in service it, too, will generate its regular cost every day it operates and constantly accumulate depreciation charges.

Basic Unit Production Cost

Now, the limiting output of any piece of equipment or combination of equipment and the operating cost of that equipment are the controlling elements in determining what may be called the basic unit production cost. To illustrate, let us assume that the output capacity of a steam shovel is 1,000 cu. yds. a day of a given kind of material, and that its operating cost in that material is $75 a day. There is not time enough available to develop here a justification for either figure. To do so would hardly be of value, but whether they are correct or not they will illustrate the theory involved as well as any. But if 1,000 cu. yds. per 10-hour day is capacity production for this shovel in the given material and $75 is its proper daily operating cost, it follows that the basic unit production cost of loading this dirt with it is 7½c a cu. yd. Moreover, this cost can only be reduced below this figure by reducing the daily operating cost, for in the nature of the case, 1,000 yds. per day being the full capacity of that shovel, output cannot be increased except by rebuilding the shovel, which, in fact, makes of it another shovel.

Wage Scales Affect Basic Cost

The basic unit production cost will vary a little from place to place because differences between prevailing wage scales will somewhat alter the daily cost of operation. The cost of fuel also varies as do the other items which comprise the daily operating cost. However, the greatest current differences in regional wage

scales, in fuel costs, etc., though in themselves important are not great enough to make it possible to establish any basis for the belief that such differences will cause the basic unit production cost on this particular work to vary more than a cent or two a cubic yard from the mean. The basic unit production cost is, of course, based on the correct use of labor, fuel, etc. It presupposes that the hauling equipment is so supplied and handled that no shovel time is lost. There is, therefore, little possibility of improving this basic production cost by modifying the personnel or the utilization of fuel, etc., on a given piece of equipment, but improvements in equipment do affect it.

Finally, as general economic conditions change, wage scales rise or fall and with these changes the value of commodities generally is somewhat altered. This naturally affects the cost of operation and so affects the basic unit production cost.

Efficiency Can Be Determined

There are two points it is desired to bring out through this method of presentation. The first of these is that, for any given piece or group of pieces of equipment, there is for a given set of conditions a basic unit production cost which is the lowest unit cost obtainable with that machine or that combination of machines. To reach it requires merely that equipment be worked at full output capacity, properly manned and properly served. In short, it becomes a standard with which actual results may be compared and operating efficiency thus determined.

The second point is that, though the basic unit production cost is not a fixed thing, varying as it does from place to place and from time to time, the variations are relatively small for such equipment as power shovels, elevating graders, concrete pavers, etc. Regional differences in wage scales are considerable, but when these are applied to a correct personnel set-up for a piece of equipment of this kind, their effect on the daily operating cost is so small that the basic unit production cost is little affected. The same must be said of variations in economic conditions. These changes are important—that is true enough—but the commonly accepted engineering view that they are vital, for example, to low cost steam shovel or elevating grader production, can hardly be substantiated when the facts are analyzed in this fashion. Variations of 10 per cent, in some cases perhaps as much as 20 per cent or 25 per cent, are encountered but it is not such variation as these that account, for instance, for the fact that there are regions in this country where grading for highway work commonly costs less than 20 cts. a cubic yard and that there are regions where it often costs over $1 a cubic yard.

Labor Wastes Not Serious

Neither can such differences as these be sufficiently explained by the incorrect use of labor, fuel, etc., in such regions. Rather extended studies of highway construction practices do show that there is a good deal of variation between the correct and the actual use of labor, fuel, etc., variations which have the effect of making actual production cost higher than it ought to be. But such incorrect practices are not limited to the high cost regions. Therefore, these differences, like those to which reference has just been made, may be dismissed as relatively of minor importance, taking highway construction work as a whole and as it exists today. The man who sets an extra man on his shovel and pays him $4 a day increases basic unit production cost only a little more than 5 per cent. This is, of course, a waste which tends to reduce profit, but wastes of this sort are not the most serious wastes in the highway field.

Efficient Equipment Important

To find the really serious wastes in most lines of our present highway work we must inquire not into the reason why one pays a little higher wages or uses more labor or more fuel than another, but we must turn our inquiry into such lines as will tell us why one man in one place consistently maintains his output close to the limiting output capacity of his equipment, while another in some other place, but, under reasonably identical conditions as to equipment and materials, rarely succeeds in maintaining better than 50 per cent of the limiting output capacity of his equipment. In short, the really important question in searching for lower construction costs in several important lines of highway work, therefore, is not the cost of labor nor the cost of the supplies but why the production of our highly specialized equipment so seldom even measurably approaches its limiting output capacity. In other words, the cost of much of our highway work is fixed not by the output capacity of our equipment, but by the rate of efficiency with which this equipment is operated.

The Bureau of Public Roads has been

studying this problem both extensively and intensively, for some time and as a result has come to the conclusion that there are a number of specific causes of low production. On the contractor's side of this problem, the first of these is the common failure to coordinate the capacity of interdependent equipment. On concrete jobs this is apt to express itself more definitely as a failure to provide enough transportation to keep the mixer supplied, but it may be a failure to provide loading facilities which operate with sufficient speed or the use of trucks which dump too slowly, etc. There are a considerable number of points at any one of which a failure to coordinate may cause under-production.

Equipment Capacity Interdependent

On elevating grader work and on power shovel work the failure to coordinate the capacity of interdependent equipment is apt to be a failure to supply enough hauling equipment properly to serve the digging units or to so operate the hauling equipment as to not interfere with the continuous operation of the digging units.

Another cause of low efficiency is undertrained operators. Very few shovel operators really know how to operate a shovel as it should be operated. Very few mixer operators operate the mixer correctly. The same is true of operators on other types of equipment. It is also true that neither superintendents nor contractors, as a group, obtain full production from even their most important machines, and most astonishing of all, that even the manufacturers of these machines seem not to know their productive capacity or how to obtain it. This is merely a statement of the fact.

Job layout is another important cause of low efficiency. If the equipment is not properly arranged and the general scheme of handling it properly worked out, top-notch production is impossible.

Length of Haul

On the engineering side—and this is the matter with which we are most concerned at the moment—an outstanding cause of low production is the length of haul as fixed in the design of the work. In the case of the power shovel used as an illustration, we noted a daily operating cost of $75 and that this was a pretty constant figure—a cost that held good whether much material was dug or little. On the other hand, it will be apparent that the number of teams required in order to transport the material which this shovel could dig would vary with the distance it must be hauled. The Bureau's studies show that teams travel about 250 ft. a minute. These studies also show that such matters as waiting while the load is put on at the shovel, turning at the shovel, turning at the fill dropping the load, etc., should not require more than two minutes per load hauled. If, then, the distance the dirt must be hauled is 250 ft., a load can be hauled every four minutes. If the shovel can put a dipperful of good common excavation onto a wagon every 20 seconds —as most shovels can if properly operated, two dipperfuls making a wagon load— a wagon can be loaded every 40 seconds, so to keep the shovel supplied with wagons a train of six wagons (4 times 60 or 240 seconds divided by 40 seconds or six) is required. If, on the other hand, the haul distance is 500 ft. the round trip for the wagons becomes six minutes and nine wagons (6 times 60 or 360 divided by 40 equals 9) must be supplied. At 1,000 ft. the round trip time becomes ten minutes and 15 wagons are needed to keep the shovel busy all the time. At 2,000 ft. 27 wagons are required and at 4,000 ft. 51. But while hauls as long as 2,000 ft. are common enough in grading work and hauls of 4,000 ft. or more are by no means unknown, it will be perefectly obvious to anyone that no ordinary grading project involves the consistent use of such hauls. On all ordinary jobs the haul varies in length from cut to cut and from day to day, frequently from hour to hour. Generally, however, the amount of material having either very long or very short hauls is a relatively minor part of the total.

Must Be Ready for Maximum Haul

But, if the highest production is to be maintained throughout the work all the transportation needed to meet the longest haul must be supplied. In other words, if a job calls for a maximum haul of 1,000 ft. the contractor must have 15 wagons available or it becomes impossible for him to maintain the highest production at all times. If the haul is 2,000 ft. he must have 27 wagons; if it is 4,000 ft. he must have 51 wagons. Otherwise, production will at times unavoidably be below the output capacity of the digging unit. Naturally, if the haul was all of the same length the contractor could be expected to provide a full wagon train merely as a matter of self interest, but in practice it never is all of the same length. As a result, what the contractor does is to furnish a wagon train which harmonizes with his understanding of haul requirements as he has previously

encountered them. Usually this means that he will send out for an ordinary power shovel or elevating grader job from six to ten wagons or a somewhat equivalent number of trucks. If we assume that the cost of maintaining a team and wagon with driver is $7 a day, which appears to be a fairly representative figure, and that ten wagons are sent out with the shovel, the daily cost of operating the wagons is $70, so the total production cost—shovel and wagons in the illustration previously used—becomes $145 a day. Ten wagons can take all of the diggings from the shovel as long as the haul is under about 600 ft., but beyond that distance the hauling equipment is insufficient and production falls. There is a production capacity so far as the loading unit is concerned, of 1,000 cu. yds. per ten hour day, but at 1,000 ft. production has fallen to 67 per cent of the possible maximum because there is not enough transportation to handle what the shovel can produce. At 2,000 ft. production is at 37 per cent of shovel capacity and at 4,000 ft. is under 20 per cent. And, it may be observed, the unit cost of handling the dirt has been affected in inverse ratio. Up to 600 ft. it was a little under 15 cts. At 400 ft. it had risen to about 75 cts. If, on the other hand, the contractor had sent out only six wagons, his daily cost of operation would have been only $117 but the highest production could have been maintained only as long as the haul was under 250 ft. At 1,000 ft. production efficiency would have fallen to 40, at 2,000 ft. to 22, and at 4,000 ft. to under 12, while unit production cost, though only 12 cts. at 250 ft., would have been about 30 cts. at 1,000 ft., about 55 cts. at 2,000 ft. and $1 at 4,000 ft.

Long Hauls Uneconomical

Of course, in each individual case the problem of what, in fact, is the most economical outfit to use on a given job is one that is easy enough for you as engineers to solve on the basis here suggested, but this is not the point I wish to leave with you. Rather, the point of importance as contractors are at present equipped is that long haul means low production and so is astonishingly and unavoidably productive of high cost. Indeed, long haul may easily become so expensive that it is as important an element in cost as solid rock. Often it is more destructive of economy in operation than loose rock. The matter is put in this way because you are all familiar with the manner in which alignment and grade are modified in order to avoid work involving classification. This is perfectly proper. A good engineer ordinarily can avoid much of the rock, both loose and solid, that an engineer of less experience would perhaps think it necessary to take out. Economy dictates the avoidance of heavy work of this kind if the avoidance can be accomplished without injury to the general value of the road. This we all recognize and as a matter of everyday practice, observe.

But if this is a correct statement as applied to loose rock and to solid rock, it certainly should be equally our practice as applied to long haul, for the effect of long haul on cost is quite as disastrous and should be quite as apparent as the effect of rock. While in the case of rock work, avoidance sometimes is impossible and when not impossbile may still be inexpedient because of the effect of avoidance on grade and alignment or both, conditions really demanding the use of long haul are much less likely to arise, because borrow and waste often can be resorted to when long haul otherwise might be required, and the design should definitely provide for this where practicable. You have all had requests from contractors to substitute borrow and waste for longitudinal haul. If this method is justifiable it should be definitely provided for in the plans, estimates and specifications used by bidders and not instead given as a privilege to the successful bidder.

Cheaper to Borrow and Waste

It must have been apparent as the effect of haul on cost was outlined a moment ago, that with the ten team outfit it cost less to haul two yards of material anywhere within a 600-ft. limit than it did to haul one yard beyond about 1,500 ft. With the six team outfit it cost less to haul two yards anywhere within 250 ft. than it cost to haul one yard 800 ft. These facts will suggest at once that as contractors are equipped, it is cheaper to borrow and waste, if the design can be adjusted in no other way, than it is to use long hauls.

In this connection it may be stated that there is no more delusive thing in highway engineering practice today than the so-called "free haul." As a matter of fact, there is no such thing as "free haul." Every bit of hauling is an expense to the contractor. The more hauling there is the more it costs him to do the work. It is quite true that he may overlook the effect of the long haul in entering his bid and so may have to pay this extra cost

out of his own pocket, but I am quite sure that none of you desire such a result. But the fact that so many grading contractors fail should be evidence enough, particularly in view of the high cost of long haul as outlined to you just a moment ago, that long so-called "free hauls" with the wide variation they permit in the amount of hauling actually required from project to project tend to destroy contractors.

Keep Haul in Reasonable Bounds

The obvious conclusion from these facts is that the objective of the designing engineer should be to keep all of the haul within such bounds that the ordinary contractor using a reasonable equipment set-up can maintain a high rate of production. It is only in this way that he can do the work at a reasonable cost. In short, he cannot work economically if you, as an engineer, have destroyed the possibility of his maintaining a high operating efficiency by producing a design that does not fit in with existing equipment set-ups and current construction methods. And we all know only too well that high cost to the contractor due to any of these methods is inevitably, sooner or later, reflected into the bid prices and the cost the public pays for the completed work.

I shall lay no great emphasis on the details of so preparing plans that economical construction will result. The careful scrutiny of a considerable number of plans with the facts which have been presented to you in mind, has developed the impression that more thought is now given to whether a balance between cut and fill is secured than to whether the haul established will make the maintenance of a high average in production possible, actual construction conditions as they really are being considered. A series of alternate long hauls followed by short hauls is destructive of economy in construction. On the short hauls the teams work at less than full capacity, and on the long hauls there are not enough teams. This is just as true for truck hauls as for team haul. Sometimes merely shifting the balance points in the cuts so that haul in both directions from the cuts is equal will convert a very poor design into a reasonably good design, at least so far as the actual cost of doing the work is concerned. Sometimes a grade must be raised, sometimes lowered, or the gradient may have to be adjusted. All of these are devices to which you have had frequent recourse. And they will continue to be the devices used to create a satisfactory design. The thought I desire to leave with you is that by the proper use of such devices as these it is possible almost entirely to avoid hauls of over 1,000 ft. and to keep the great bulk of the hauling within 700 ft. Where this is done in the original design, the contractor can maintain a high rate of production with an ordinary outfit and the practical result is grading work at a reasonable cost.

Road Builders Are Public Servants

We are, all of us, the servants of the public. Our work is the creation of a public benefit for which the public pays. Our duty is to create as economically as possible. There is, therefore, in the situation just discussed more than a matter of professional proficiency. There is, in fact, the matter of our obvious duty to the public we serve. Where there is waste it must be discovered and stopped. Poor design is followed by pure waste. The duty which rests on us to take more heed in this matter needs no other emphasis.

CONTROL OF HIGHWAY MATERIALS AND RESULTS

By H. S. Mattimore, Engineer of Tests and Materials Investigation, Pennsylvania Department of Highways, Harrisburg, Pa.

(Paper read at 1927 meeting of American Road Builders Association.)

In the fabrication of any structure, consideration must be given to the fact that its service efficiency will be controlled by many factors, such as suitable materials, skill of workmanship, and of observance of proper precautions controlling good construction. Engineers who investigate pavements or other structures for reasons of defect or failure find that in the large majority of cases it is difficult to trace the failure of an efficiently designed structure to any one cause. Usually, as is the case with poorly controlled construction, a combination of several or all probable errors or evasions can be traced.

Our present discussion is specialized on materials control and the results in Highway Work. An examination of the Highway specifications of any large organization will readily show that material qualities are one of the essentials in such specifications. As these specifications are changed, as a result of experience we observe that if anything the sections dealing with material qualities are elaborated

upon. Therefore, are we not justified in concluding that the use of good materials is considered a major factor in construction? We cannot conceive, at this age of engineers expecting to obtain an efficient concrete road slab with poor cement or structurally weak aggregate, or a satisfactory bituminous surface with unsuitable material. Some years ago experiments of this kind were tried unintentionally either through inefficient supervision or lack of knowledge. The results of such construction in general were found to be unsatisfactory, as our present state of knowledge leads us to believe would be the case.

An Interesting Example

I had an opportunity to observe several of these conditions—for example—a State Highway Department constructed a concrete road in the outskirts of the city using local sand as a fine aggregate. About a year later the city department constructed the continuation of the same road. To make a more interesting example, the same contractor built both roads, with sand from the same source. The coarse aggregate in both cases was stone of a very good quality. About three years after placing, large sections of the City road were a total failure, while the entire road surface constructed by the State was in excellent condition. Many causes were given for the failure of this road, but the most persistent one was the use of a poor quality sand. The use of a sand from a local pit was commented on by some commercial material producers from the standpoint that no good results could be expected from using material from the so-called wayside pit, but somehow or other the State did secure sand from such a pit which made concrete that gave very efficient service value. A detailed examination of the local sand pit demonstrated that it was possible, without proper control of the material being produced, to obtain an unsatisfactory aggregate, and the probabilities are that the quality, grading and silt content of the sand was a major factor in the failure of the City road.

A Comparison of Aggregates

An example illustrating another phase of this problem—during the year of 1919-1920, in our own State we constructed one mile of concrete road with a local stone aggregate. A study of the surrounding ledges convinced us during the construction of the Highway that the stone was of an unstable character, therefore, the concrete on the five miles of the remainder of the contract was constructed with stone from another source. Both sections of this contract were constructed by the same contractor, under the same engineering supervising personnel, and other than the change of coarse aggregate, the same materials were used. About the third year after completion, the section with the unstable aggregate showed signs of surface rupture. This has been progressive and at the present time, some five or six years after completion the road is kept in suitable condition only at a heavy maintenance cost. Meanwhile, the section of concrete with the sound stone aggregate has been in excellent shape for the entire period at average maintenance cost. Constant control, close observation of construction, detailed inspection of the quarry, and of the surrounding exposed ledges, no doubt saved five miles of this road, of which the increased maintenance alone would probably pay for material control on a number of projects.

Other examples of this kind could be quoted, but usually many other factors enter into the cause of failure to complicate the conditions making it difficult to definitely trace the effect of any single cause.

The service of thousands of miles of Highway surfacing under heavy traffic and the difference in service value of Highway constructed under different engineering supervision where all other conditions, such as specifications, climatic and subgrade conditions are essentially the same, is a major argument for competent inspection of which competent material control is an essential part.

Material Control

Material control is a safe insurance for the use of specified materials. Preliminary tests are essential, but are of little or no value unless some positive check is maintained on the material actually being used. I have never seen a specification for any structure which does not specify material qualities in more or less detail. Such specifications without control may and in many cases do fall short of their intent. For example—in bituminous mixed pavements we specify both the grade and quality of the bituminous materials and aggregates to be used. We know that considerable increase or decrease in the quantity of bituminous material will lead to a failure, and other variations from specifications will have this effect on the service value of the pavement. Experience has taught the

Highway field that with this type of construction detailed inspections on the quality of the materials and the mixes are absolutely essential. The reason for this can be readily observed when we compare the results obtained with this type of road in large cities or State Highway Departments, which have efficient engineering inspection organizations, with other municipalities where inspection is of secondary consideration and of the political brand.

The use of Portland cement concrete as a surfacing has led to a large amount of research on concrete and its constituent materials. Many designs for mixtures have been formulated and tried with more or less success. Proportions and grading of aggregates are the foundation of many of these design theories, and their application required competent material control.

Water Cement Ratio Design

The water cement ratio design, which has been advocated as a concrete quality measure from the standpoint of economy and its ease of application, is applied by maintaining a constant ratio between the water and the cement content to obtain given strengths. An increase of water without increasing the cement proportion would unbalance this ratio and produce a concrete of lower strength. To produce concrete of the maximum strength the water content should be reduced to the amount required to make a workable mix. The amount of water necessary to produce a workable mix, the cement proportions remaining constant, depends to a large degree in the grading of the aggregate, therefore, it seems reasonable to conclude in the application of this theory that an efficient control to assure the use of well graded aggregates is an economic measure.

The cost of operation of a Material Division whose duties include the testing of all aggregates and supervision of full material field control will vary to some extent at different locations. These costs will be regulated by the type of organization, geographic conditions, and the location of the general material sources of the State, but ordinarily these costs should not exceed five-tenths per cent of the cost of construction, and under some organizations where accurate cost has been kept they have been found to run well under this figure. So considering such operation as an insurance for good construction, it is certainly obtained at a low premium rate.

It hardly seems necessary to further emphasize the importance of material control from the standpoint that if it is considered essential for good construction to definitely specify material qualities, why not make these specifications of some value, and be assured that the materials actually used are of the qualities specified. To function economically materials specifications should be based on a thorough investigation so that we definitely know that materials of such quality are or can be produced within reasonable hauling distance.

Slab Strength of Surfacing

A step in advance was made in Highway Engineering within the past year or two when consideration was given to the opening of Portland cement concrete roads to traffic, based on the slab strength of the surfacing. A trial in our State of this procedure on selected roads in different locations has convinced us that it is a distinctly forward step. Transverse field tests are made on concrete specimens cast from the mixture being placed, and as a result of these tests we can definitely determine the traffic carrying capacity of the slab at different periods and regulate the traffic accordingly.

As a result of research of Portland cement concrete and its constituent aggregates, we are finding that the slab strength of the concrete road surface is regulated by many different factors, that is, water content, the kind of aggregates, efficiency of the curing and the temperature and humidity conditions at the time of placing and during curing periods. These conditions vary on different contracts, in fact under competent control the least variance is found in material quality, but the other factors are of such importance and are so difficult to control that the concrete being laid on different contracts will show variation in transverse strength. The one big future problem for the Highway Engineers is to try and secure concrete of uniform quality on all his projects.

Some of these factors are phases of design, for instance—different types of aggregates are available for concrete construction, tests indicate that one aggregate gives higher slab strength than another. If this factor is fully established by research now under way, it seems we might give consideration to classifying the roads made with these different aggregates and obtain a differential in bid in locations where traffic conditions would warrant us using a concrete of lower slab strength made with the weaker aggregate.

A Differential in Final Pavement

Some Highway organizations have established a differential in final pavement to the contractors, depending on the riding qualities of the road surface as rated either by straight edge measurements, profilometer ratings or rating of riding qualities obtained with other devices. Other Departments test finished roads for depths and deduct for shortage. These are rating qualities of a road which although built under inspection are the direct responsibility of the contractor. We have heard considerable talk within the past few years, and some specifications have been based on the idea of making a contractor fully rsponsible for the finished work and demanding that it meets certain test qualities before acceptance. At the present time this may or may not work out in practice, as it is doubtful if we have arrived at the stage in Highway work where we can expect the contractor to stand fully responsible for quality tests, although I do not believe that he can control with good workmanship some of the factors which affect the quality.

A feature that is very notable in Highway construction is that roads built by different contractors under practically the same engineering supervision are not always deserving of the same rating. I do not refer to major defects or deliberate evasions in specifications, etc. What I especially refer to is at the final inspections at different roads, when a comparison is made one is found to have exceptionally good rating while an adjoining road may come within specification allowance and yet is not comparable in finished detail with the first one. The reason for the higher rating on the first road can be traced to variation in workmanship and a general pride in results on the part of the contractor and his employees. Many times it has been noted that the general aesthetic conditions, such as neat slopes, and general appearance is better on one road than another. These are items that are covered by general clauses in specifications, and are difficult ones to attempt rectifying after the work is finished, the general impression being that they are minor details, but every engineer who has responsibility for the final acceptance of any Highway contract realizes this. Many times he probably wished some provision existed by which he could either penalize careless constructors or reward the competent contractor who takes pride in his work and always has competent employees.

The traveling public have become educated to differences in riding qualities of different road surfaces, which exist even in roads of the same type. Highway engineers within the last few years are giving special attention to this phase of construction. Some departments as mentioned above penalized the contractor by deducting from his final payment for surface irregularities as rated by specification requirements.

The next forward move should be to rate the entire road, taking into consideration quality of mixture as affected by mixing, placing and curing, determined by transverse tests for concrete, and density, toughness and absorption limit in bituminous mixes, riding qualities of all types of surfaces, shoulder and slope finish, which add to the efficiency and appearance of all highways.

Rating of this kind for acceptance would encourage the contractors who take pride in their work and get good detail workmanship, and penalize the class of contractors who work along the lines of only doing what they are forced to do by supervising inspectors, with constant objections to performing operations definitely called for in the specifications.

Fortunately on big operations in highway work of the present day the contractors in the obstructionist class are in the minority, but they still exist. Moves toward their elimination should be encouraged and would be welcomed both by contracting and engineering associations.

I feel that the general contractor's answer will be that the present system of awarding public work to the so-called lowest responsible bidder does not encourage the best work on the part of a contractor. The correction for this can be along the line of a better interpretation of the term, "responsible bidder," which at the best, apparently, from the legal standpoint, is anyone who can furnish a bond and has control of sufficient capital to carry on the work.

Correction of this kind can and eventually will be made through the contractors' associations with full support of the engineers.

SHOULD ENGINEERS' ESTIMATES BE MADE PUBLIC?

By Arthur W. Brandt, Commissioner of Highways, State of New York, Albany, N. Y.

(Paper read at 1927 meeting of American Road Builders Association.)

The title of this paper asks a question which the conclusion is supposed to

answer. But the advantages and disadvantages of the publication of engineers' estimates are so nearly balanced that the writer finds it difficult to draw a conclusion which arguments justify and which can be successfully defended. In New York State, where the question has been argued for years, there are champions on either side and any discussion must, of course, be predicated on experience in that State, where engineers' estimates are published in accordance with the law.

The first appropriation for highway construction in New York State, made over 28 years ago, carried with it the provision that the engineer's estimate, plus a percentage for engineering and contingencies should be appropriated for each contract; that with the advertisement of the contract the engineer's estimate should be published; that any bid exceeding that estimate was informal and must be rejected, and, last but not least, that the original appropriation set up for the construction of the road must remain so obligated until the completion and acceptance of the contract.

Engineers' Estimates

Engineers' estimates are based of course, on contractors' bids. It was only natural that the engineers should wish to keep their estimates as near the contemplated bid as possible, in order that a minimum amount of money should be tied up until the completion of the contract. Such estimates up to four or five years ago averaged about 10 per cent over contractors' bids. This caused a group of "shoe-string" or "fly by night" contractors to spring up—men who had little or no experience or cost data on which to base their proposals and generally but little capital with which to finance their contracts, and who bid on the engineer's estimate rather than a knowledge of the cost of work. Their method in securing a contract was simply to cut the estimate two or three per cent more than the average cuts of experienced contractors. Indeed, it was not uncommon in years gone by to hear an inexperienced bidder boast of securing a certain contract by guessing how much an experienced man, whom he knew wanted the contract badly, would cut the estimate and then cutting it one or two per cent more. It was common practice in those days to ascertain the prospective bidders on a contract and then "beat them to it."

Requires More Time

To the layman, this might seem to be beneficial to the State, in that the work was done at a lower cost, but more often than not this happy result did not materialize. In the first place, such a contractor usually required much more time, due to lack of experience, equipment, capital, or, possibly, all three, and the extra engineering charges more than made up the difference between his bid and that of an abler firm. But, more important still, the public was deprived for a greater period of time of the use of the highway, and, after all, time is the essence of almost any contract and particularly of road construction.

The obvious solution of such a situation would be to reject the proposal on the ground that the contractor was not responsible and award the work to the lowest bidder, who, in the opinion of the awarding officer, was responsible. But, unfortunately, in New York State it has been ruled that any contractor who can furnish bond is, in the eyes of the law, a responsible bidder, and not in the memory of the oldest highway engineer of the State has a contractor been unable to secure a bond and, with very few exceptions which usually resulted in compromises, the State has never collected on defaulted contracts from the bonding companies without long, hard court battles. Surety companies are eager to bond but slow to settle.

New York Law Amended

But New York State has largely done away with this type of contractor. In 1924 the Highway Law was amended to allow the appropriation set up for a road to be reduced, after the contract was awarded, to the actual bid price plus 10 per cent for engineering and contingencies. Although estimates will still be published, they need be and are of little or no value to the contractor, as they are made from 15 to 30 per cent higher than the actual value of the work, and for the last two years have averaged about 23 per cent above low bids. In other words, we are complying with the law in publishing the estimates, but we are getting results that might be expected if no estimate were published.

This change has been beneficial in more ways than one. In the first place, it is dangerous to bid on the estimates now, as such a bid may be so low as to be ridiculous and indicates a losing contract. As a result the ranks of "mushroom" contractors have thinned amazingly in New York, at least as far as State highways are concerned. During the last three seasons, more than 400 contracts have been

awarded to low bidders only and not one of them has defaulted. Before 1924, several defaults a year were common. In the second place, the high estimates have attracted desirable bidders from other states. It is a peculiar attribute of a highway contractor that he is loath to bid on an estimate only 5 per cent above his opinion of the value of the work, but he is keen to bid on one 25 per cent above that opinion. For instance, from 1921 to 1923, inclusive, several contracts were advertised and no bids received. The estimates were immediately raised and the contracts re-advertised. Not only were many bids received, but they were nearly all less than the original estimates on which these same contractors declined to submit a proposal. At any rate, New York is now enjoying the competition with our native contractors of many high class firms from as far west at Minnesota. We are convinced that increased estimates are responsible for this competition.

Disadvantages of Non-Publication

Now, for a brief discussion of the disadvantages of the non-publication of engineer's estimates, the advantages of which have been taken care of above.

To the writer, only one disadvantage looms up that can be called important—the greater danger of unbalanced bids than would be present were estimates published and limitations placed on the amount that can be bid on any item, such as is used in New York. There is considerable opportunity for a contractor to unbalance his bid when estimates are published, but when they are not published all restraint is removed.

The bulk of the money in any highway contract falls into two items. First, excavation, which may be unclassified or divided into rock and earth, and, second, pavement, which may, in the case of concrete be carried entirely in one item, or, in the case of macadam, be divided into several. Some years ago, proposals were asked on a certain grading and paving job in New York. The estimate indicated that the excavation would run about 20,000 yds. per mile, which was in error, as it ran only about 10,000 yds. One contractor discovered this error before the bids were received and bid 1 cent per yd. on excavation, increasing at the same time his bid on pavement items by approximately the amount saved. He was low bidder and was awarded the contract. While he suffered a large loss on excavation, he much more than made it up in pavement items. Shortly thereafter a rule was adopted that a bid on any item more than 10 per cent in excess of the estimate rendered the entire proposal informal.

Earth Excavation

Only two years ago a contract which included several thousand yards of rock excavation was advertised. This rock was of a shaly character and the estimate was $2.50 per cu. yd. One contractor discovered that all of it could probably be removed with pick and shovel and most of it with a power shovel without blasting, which thereby placed it in the category of earth excavation. He bid 1 cent on rock and spread the amount saved over the other items of the contract. The contract was awarded to and completed by him.

If these unbalanced bids had been properly noted and the estimates of quantities checked and corrected and the contracts re-advertised, the State would have saved many thousands of dollars. Furthermore, in both instances cited, if the final estimate quantities had been used in the original estimate, the bids of several other contractors would have been lower than the bids of those to whom the work was awarded.

Some contractors, prone to unbalance their bids and take advantage of errors in the estimate of quantities, contend that they should be allowed to reap the fruits of their acumen. While no one can censure them for wanting to gamble on a sure thing, yet no highway official has the authority, legal or moral, to gamble with the State's money and all such bids should be rejected, if after examination, the estimates are found in error. Other contractors, moreover, should have the assurance that the quantities, as advertised, are as nearly correct as they can be estimated.

Selection of Contractors

A much more important thing than the publication or non-publication of engineering estimates, in the opinion of the writer, is the proper selection of contractors. Our law should be so drawn that awarding officials can require more than a bond as a proper qualification for the award of a highway contract which may run into many hundreds of thousands of dollars. Officials should have the authority to investigate the contractor from the standpoint of experience, equipment and organization and all bidders should be able to submit with their proposals a complete financial statement showing their net worth in liquid assets. The official should then have the authority to absolutely re-

ject the proposals of all contractors who are not able to meet a certain minimum qualification set up as necessary for not only the proper completion of the contract but for its proper prosecution, in order that it may be finished in the shortest time consistent with good work. He should, moreover, have the authority to award to the lowest bidder who can meet the necessary qualifications and not be obligated to re-advertise because the low bidder is not responsible.

When such a system is devised, the status of highway contracting will be very much raised and will be not only more beneficial to the general public, for whom the work is being done, but will rebound to the benefit of those contractors who are well equipped and well qualified for highway construction but are unable to obtain work because of the cut-throat competition of men not properly equipped to do the work.

ECONOMIC WASTE IN CONSTRUCTION OF PUBLIC WORK BY DAY LABOR

By Gen. R. C. Marshall, General Manager, Associated General Contractors of America, Washington, D. C.

(Paper read at 1927 meeting of American Road Builders Association.)

Throughout the hearings on Federal Bill, HR 8902, limiting day labor construction by Government Bureas, not a single individual who testified in opposition recommended the policy of building public works with public forces. I have never met a genuinely educated person with experience in administering or performing construction who would recommend that policy. There seems to be a general agreement, excepting the socialist, that it tends to produce a waste of public money, self perpetuation of individuals in public office and an easy means of graft. Yet the volume of day labor construction continues to increase.

Those men who were most inimical to the Federal Bill expressed a preference for contracting with responsible contractors. They took pains to disclaim any belief that public bodies should engage in the contracting business and were extremely commendatory of the services rendered by private companies. Yet all of them had their special exceptions in projects which they desired to perform with government forces. Apparently day labor was all wrong, but if the individual could carry out his specific projects and escape being identified with the policy itself, then in his individual case it was perfectly all right.

In the case of the army engineers these special cases which in their view are too difficult or otherwise unsuited to contracting, have involved an expenditure of thirty or forty million dollars a year and the purchase of some fifty-eight million dollars worth of equipment. Other Federal agencies also have their special exceptions, likewise states, counties and municipalities, until the exceptions seem likely to become the rule. In some instances they constitute nearly a hundred per cent of the work.

Many Believe Themselves Exceptions

It seems that many engineers and other public officials believe their projects to be among the very few that can be economically performed by public forces, or that they themselves are among the few endowed by providence with the ability to carry out a construction program successfully by day labor. Unfortunately a few are correct in the latter belief, and their accomplishments stand out before the less able multitude as a shining example, not of individual ability, but of the mere working of a system. Consequently, we see a host of public bodies that desire to experiment with the system.

Practically every public project upon which it has been possible to uncover day labor costs for comparison with bids from contractors shows a loss of money against the system. Exact comparison is not possible because public bodies seldom account their costs in full, but in several notable cases the excess varies from thirty to a hundred per cent. A hundred percent overrun of the estimate used for appropriation or for judging the reasonableness of contractors' bids is not at all uncommon.

A vast amount of construction is performed each year by public force agencies which have no chance whatever of achieving economical results. The Engineer Corps of the United States is in such position. To do some thirty or forty million dollars worth of work it maintains that fifty-eight million dollars worth of equipment and it cannot possibly bring the cost of a year's work down to a level with the bids of private companies. The excessive investment in equipment prevents it. They are obviously equipment poor.

I make no charge here against the army engineers except that they are human. The Corps is their life work and they can-

not help desiring to expand its activities. But like every other public agency, it is subject to the inevitable business inefficiency of those who do not have to construct within their estimated cost or pass out of existence. The absolute necessity of efficiency and economy, which spurs the private company toward ingenuity, speed and refinement, is lacking in their work.

Should Not Feel Proud

Except as a personal accomplishment those few individuals who do succeed in their day labor projects have no cause to feel proud of their achievements. They have benefited their communities little, if any, and have been responsible for the squandering of millions of dollars by others who follow their example. They may have saved a few thousand dollars in a specific case, but they have left the public agency burdened with a system which is sure to be wasteful and may be criminal in the hands of their successors. The public body, like the social family, can rarely claim two men of genius in succession.

At the present time I know a man who is conducting all of the construction work of a fairly large city by day labor, and what is more, doing it successfully. His cost summaries are in my office. But his predecessor, who tried the same thing, made a total failure and I am informed wasted many thousands of dollars. After meeting this public official I know why his operations are successful. In the first place he is utterly fearless and will stand for no deadheads on his payroll or no political interference from the mayor or anyone else. He has the ability to pick subordinates who are loyal and capable and I believe would instantly leave the service of the city if political maneuvers made it impossible to maintain the efficiency of his organization.

Constructing for Profit

But the fascination of constructing for profit is inherent in a man of his type, and public service does not offer an attractive field for his ability. To such a man the security of a salary and its other advantages makes very little appeal. It is my belief upon good foundation, that very soon his city will lose a capable official and the contractors in some locality will gain a formidable competitor. This man was one of the few whom providence favored and he will never be contented except in the game of business. Incidently, he stated in my office that ninety-nine times out of a hundred day labor operations were wrong. Thus it occurs almost invariably where the ability to manage construction successfully is possessed by a public official.

No one can say that this public official has not done a remarkable thing, but what has it gained the public. He has probably saved his own city a few thousand dollars, but he has helped to undermine one of our basic industries and has caused other public officials to follow his lead. Practically all of these will fail. When he decides to enter private business, his city will have a heavy investment in equipment, a large public payroll, or in other words will be loaded with an inherently unsound system. If the man who succeeds him is a genius, well enough for a time. If not, the city will waste many times what he saved before it wakes up and realizes that an individual and not a system produced the present results. For this reason, I consider it unfortunate that the country does contain a few individuals who can do economical work with public forces.

In my opinion one cause of the increasing volume of day labor is the failure of many officials to realize that strenuous effort must be exerted to hold construction costs within a reasonable estimate. For some unaccountable reason, construction management is not generally regarded as a highly specialized vocation, requiring its special training and experience. We recognize that the manufacture of buttons, for example, requires its special experience, technique, plant management and financing. We even recognize that the button business may be attended by unforeseen risks that will make it an unsafe venture, but with respect to construction, similar conditions are certainly ignored.

Cities Are Willing

Scarcely any city would approve of its officials engaging in the manufacture of buttons, clothing or automobiles, yet it is willing to have them engage in the far more hazardous enterprise of construction, believing that the venture will prove successful. Some thoroughly competent engineers do not seem to realize the differences between engineering and business management of construction, or realize that they may be a complete success in one and a total failure in the other. That the two types of mind required are thoroughly different is well exemplified in the failures of technical men, long trained in their own vocation, who finally enter the field of business. Of course a considerable number of en-

gineers who have succeeded in business will disagree with this statement, but I believe a careful analysis will demonstrate that those men themselves have succeeded in spite of their technical learning and not because of it. They were men of sufficient caliber to succeed as either the technician or the business executive.

I suspect that one cause of the contractor's intensity in this day labor issue pertains to something besides a loss of business. To lose the market for his service is bad enough, but when in addition the average garden variety of politician tells the public that he can build more efficiently than the contractor and can save the enormous profit which all contractors are supposed to make, it is enough to make an experienced contractor see red.

This saving of profit is a matter worth considering and some interesting information on the subject is afforded by the latest report of the Income Tax Unit covering the year 1924. That year, as I recall, was a relatively favorable year to contractors. According to that report, there were thirteen thousand two hundred corporations engaged in construction, of which about two-thirds made some money. The other third lost about forty-two million dollars and I judge principally on public construction. Outside of the industry this condition may be puzzling, but in the family where the situation is known, the only puzzling thing about it is where those contractors obtained forty-two million dollars to lose.

Enormous Contracting Sales

According to the official report, they did not obtain very much of it at contracting. Those thirteen thousand companies had gross sales, which I presume means contracts, amounting to one billion eight hundred million dollars ($1,800,000,000). In performing their work they spent one billion five hundred million for labor, materials and other direct expenses ($1,500,000,000) which left a gross margin of about three hundred fifteen million dollars ($315,000,000) or practically eighteen per cent.

There are people in the United States who imagine that eighteen per cent is about the net profit that construction companies make on their work, but not so in the favorable year of 1924. That eighteen per cent represented the sum available from construction receipts, to pay compensation of officers, interest, taxes, depreciation and miscellaneous expenses, income tax and then the profit. Three hundred and fifteen million dollars gross margin sounds like a lot of money, but it was just about half enough to pay these items of expense.

For thirteen thousand companies those items amounted to six hundred and sixty-one million dollars ($661,000,000) or more than double the amount available to pay them. In other words, these companies as a group, not merely the one-third that lost money, were three hundred million dollars in the red on their construction operations for 1924. Such figures as these make one wonder where the newspapers first obtained their universal belief that all contractors are wealthy, or why so many individuals with a little money think that contracting is the easiest place in the world to make more; and naturally one meditates as to why the day labor proponent is so hell bent on saving the contractor's profit. They need not take the trouble, for it would be a duplication of effort; the contractors themselves seem to be saving the profit. What they appear to need is someone to save the losses.

Serious Organic Losses

Three hundred million dollars showing in red for construction operation indicates serious organic illness, and we may well be amazed that the industry is able to shuffle about from year to year without passing out of the picture. However, the answer is very simple and applies equally well to the question, "How can any man habitually gamble and still have money?" Obviously, he must have some other source of income than his gambling. Such is the case with construction companies as a body.

According to the income report these thirteen thousand corporations had a net income from sources other than construction, amounting to four hundred and forty-four million dollars ($444,000,000). This sum plus the gross margin of three hundred and fifteen million dollars ($315,000,000) enabled them as a group to pay six hundred and sixty-one million dollars ($661,000,000) overhead expense and come out with a profit of ninety-eight million dollars. As business concerns conducing a number of activities and possessing various sources of income, they made ninety-eight million dollars, but as contractors they made the public an acceptable little present of some three hundred and forty-five million dollars ($345,000,000).

This does not mean, of course, that none of the construction companies made money on their construction operations,

for a considerable proportion of them undoubtedly have done so. Also it does not represent the condition with respect to individuals and partnerships concerning which no segregated construction figures are available. The thirteen thousand were all incorporated. However, there is no reason to believe that individuals or partnerships have fared better than corporations.

Taxpayer Loss Is Illogical

To say that losses of these companies are ultimately paid by the taxpayer anyway under the present system appears illogical. Contractors estimate and bid by job with none too careful attention to overhead expense and I question whether a construction company would ever obtain a contract under present competition if its estimate included any portion of the losses sustained on a previous project. This three hundred million dollars came principally out of the pockets of general and sub-contractors. If the work of these companies had been performed by public bodies or by private owners unprotected by contracts, it is easy to perceive then who would have paid the bill.

On day labor operations the overrun of expense is passed directly to the taxpayer and he cannot escape it. He does not even have the opportunity to insure himself against an overrun of cost. But when projects are contracted, all of that overrun, whether due to labor rates, material prices, freight rates, bad weather or inefficient management, is the construction company's own private funeral. When a public body exceeds its estimate, that situation is of no vital moment to the public official one way or another. He is not responsible for the overrun. Under such conditions, it is not in the cards that public bodies can achieve as high efficiency or as low cost as the private contracting company.

Touching on Efficiency

A thorough discussion of relative efficiencies of public forces and private organizations is not here feasible, but I should like to advance one or two pertinent ideas. The cement manufacturer knows that no public body can operate a cement mill, count all of its costs and deliver cement of quality and price equal to that of a private company. But the cement manufacturer is not sure that the same holds true of contracting. Engineers are quite certain that the contractor cannot satisfactorily perform the service of design, but often feel competent themselves to manage construction.

The successful politician's chief vocation is politics, good, bad or indifferent, but for some unaccountable reason a considerable portion of the populace imagines that he can successfully manage construction. He may have run on a prohibition platform or he may have been put in office because he was antagonistic to big business, but I never heard of one gaining office because he was an expert in construction. Frequently, however, this does not deter him from undertaking the expenditure of vast sums with public forces and he somehow succeeds in convincing his constituents that he can save money.

There is one other point which should be noted with respect to public bodies that have had trouble with irresponsible contractors and have turned to day labor for relief. Several engineers in charge of state and county work have stated that unless the bonding of irresponsible bidders ceased they would be forced against their will to do their work with public forces. I have no desire to criticize those men, but they have obviously overlooked a vital point. If their political surroundings are such that they dare not even throw out the irresponsible bidder and award only to reliable concerns, then those surroundings are such that not even a genius could safely undertake construction with public forces. Under such conditions day labor is but a step from bad to worse.

Statistics Not Available

According to modern methods, this subject should probably be presented with a compilation of statistics, showing just how many millions of dollars of the taxpayers' money are wasted each year by day labor. But at present such a compilation cannot be made for the use of any party to the issue. It is a matter that must be determined principally by analysis and reason. Fortunately, however, we can recognize certain simple, obvious facts and principles which are prima facie evidence against the system.

We know that Government agencies, under one pretext or another, reject bids and then spend thirty or a hundred per cent more than would have been spent by contract, also that states, counties and municipalities do the same. We know that one Government body has fifty-eight million dollars worth of equipment, which will forever prevent it from exercising economy unless the ratio of equipment investment to appropriation for work is decreased many fold. Public bodies will

not fully account their costs and reveal them for comparison. Such an attitude indicates that something is wrong. Their attitude lends weight to the opinion that in ninety-nine cases out of a hundred public bodies spend more for their projects by day labor than they would by contract. The occasional exception to the rule does more harm than good. It is not the public body's cards to achieve efficiency. Contractors' profits are not alarming except to the contractors, and with present competition any intelligent public official, if he cares to make the effort, can drive proposals down to actual cost. If he is mean enough in disposition, he can drive them even lower. In other words, from practically every point of view except that of some individual official or bureau, day labor operations appear economically and often morally unsound. The qualitative analysis is complete enough to clearly indicate its character. Therefore, why should we defer action for a quantitative analysis to show whether the loss is ten million or a hundred million dollars a year.

The hope of general contractors as I see it reflected in their National Association, is that some of this energy spent on day labor may be turned to a more useful purpose. There is much that can be done to improve the contract system and no system is without its faults. Probably every motive or complaint, real or imaginary, which now prompts the day labor proponent to act, can be eliminated by cooperation between responsible elements on both sides of the fence.

Inter-Group Cooperation

We in the construction industries and professions seem to be the last to realize what a paying investment may be made out of inter-group cooperation—not merely cooperation between individuals of one group—but between the responsible elements of those who finance, design, supervise, build or furnish materials and equipment for construction. Each has its problems, centering mainly on the irresponsibles or ignorant ones within its own or other ranks, and it is astonishing how quickly those problems disappear when sincere men get their feet under a common table. If the responsible elements in construction, including public officials, can learn to shake hands instead of fists, the day labor problem will probably settle itself to the satisfaction of all.

MIXED MACADAM PAVEMENT

By R. M. Smith, Chief Engineer, Department of Public Highways, Ontario Province, Toronto, Ontario

(Paper read at Fifth Asphalt Paving Conference, Washington, D. C., November, 1926.)

The name "Mixed Macadam" is given to the type of pavement about to be described possibly for no other reason than the fact that there is a slight resemblance to ordinary macadam and secondly because no better name seemed to present itself.

Mixed Macadam is the result of the insistent demand by the motoring public for a high type road which can be constructed rapidly and cheaply and at the same time carry traffic while being constructed. It possibly would not be amiss here to explain as briefly as possible the road development in the Province of Ontario. Active construction started about the year 1919. Many miles of road in the Province previous to this had received a light treatment of gravel and although the roads were generally passable no attempt had been made to widen the grades, improve the alignment or cut down the hills. Since 1919 practically the entire system of Provincial Highways has been graded, many miles regravelled; the big percentage, however, being paved. Every mile built or paved has meant increased traffic, particularly tourist traffic. Every effort is made by the Province of Ontario to foster this class of traffic. During the year 1925, 1,290,000 cars from the United States crossed the Canadian Border via Ontario ports of entry. This year the indications are that the traffic is at least twenty per cent heavier, and next year when the main highway from Detroit in the west to Montreal in the east has been completed a much greater increase in traffic is expected. The Provincial standard calls for a road graded from shoulder to shoulder, 30 ft. in width, the paved area 20 ft. in width. At one time the Government considered the construction of pavement one-half at a time carrying traffic on the other half. The extra cost running frequently as high as $10,000 per mile, however, soon dissuaded Government Officials from continuing this practice. The next difficulty was the finding and maintaining of suitable detours and finally we encountered the areas where detouring was next to impossble.

The Department maintains at the University of Toronto, a fully equipped highway Laboratory. This laboratory is under

the direction and guidance of an Engineer who is constantly in touch with the District Engineers throughout the Province. The exchange of ideas, both as to theory and actual practice has resulted in marked improvement in our Highway work.

This year the Engineers on Provincial work were asked to design a type of pavement that would meet all the requirements of a high class pavement and at the same time carry the traffic with little or no interference. Engineers, I may say, are giving every encouragement along the line of experimental work, the Government being ready at all times to investigate and develop any idea which is at all practical.

The development of mixed macadam followed as a result of our study of the construction of bituminous penetration surface. Bituminous Penetration surface is, and has been accepted as a superior type of pavement capable of carrying very heavy traffic with light maintenance for many years. It is built in Ontario 3 ins. in thickness on concrete or macadam base. The greater part of the stone used in the construction of this pavement is of a size that will be retained on a 1¾ in. ring but will pass 3 in. ring opening. This stone after light rolling is treated with bitumen, chinked with ¾ in. stone and rolled until thoroughly consolidated, the surface later covered with ⅝ in. chips. Two gallons of Bitumen per square yard are used in the construction of this type of road. Experience has proven that the voids in stone in the surface are not entirely filled. A little mental calculation will also indicate that the bitumen will run at least 6 per cent by weight, with a possibility that considerable stone is not covered. The Department has taken the stand that the success of bituminous penetration must be accepted. Granted that it is a success, why not improve on the type, by having in the first place all materials thoroughly dry, the stone used properly and evenly coated with bitumen? Why not fill the voids as far as possible, why not take the entire quarry output, screenings included, thereby lessening the cost?

This year we are building as an experiment, 20 miles of mixed macadam pavement, 13 miles of this length from local quarries and 7 miles from local gravel pits. In each case the pavement is being built, on what is accepted in Ontario, as a fair gravel road. The pavement is at present being laid in two courses, 3 ins. each. The Department had in mind originally to lay the pavement in two courses each course to be 2½ ins. thick, the first section laid, however, had the appearance of ravelling, and secondly, it was felt that the finished pavement, 5 ins. in thickness, did not contain sufficient body to carry heavy traffic.

The method of construction is simple and definite. The selection of the quarry or pit is particularly important, it goes without saying that only the best of local material should be considered, the quarry materials given preference. Crushed rock with its angular shapes gives key and bond that can hardly be obtained with gravel. If possible to obtain a quarry near a railway siding, a further advantage is gained in that asphaltic materials can be shipped in tank cars rather than drums thereby saving several dollars per ton, and many dollars per mile of road.

The stone after leaving the quarry face is passed through the crusher the oversize being recrushed if necessary, until all stone will meet the specification. The material is then conveyed by elevator buckets and belt conveyor to the drier, the flow of material being continuous, the object of this is to keep the stone mix consistent. The stock-piling of stone demonstrated the fact that the large pieces would roll to the outer edge of the pile, while the smaller sizes would work down into the centre of the pile. The stone after reaching the revolving drier is heated to 300°F, and thoroughly dried before reaching the hopper, it is then ready for mixing with the asphalt which has been preheated in suitable melting kettles to a temperature equal to that of the stone. The materials both stone and asphalt are then properly proportioned by weighing and thoroughly mixed in a twin pug or batch mixer for a period of 45 seconds after which the mixture is conveyed to the roadway. It might be of interest to note here that the asphalt used requires to have a penetration at 77° F 100 grams 5 sec. between 75 and 85.

The subgrade is prepared by scarifying, reshaping and rolling until thoroughly consolidated. On some of the work this year we have then placed 3 in. plank along the edge of road with the thought that, first, it would give the finnished pavement a better appearance, and secondly it would be a guide to rake men to determine thickness of courses. Some of our district engineers object to this method, taking the stand that a sharp edge is left at side of the pavement which must be protected by placing loose stone. They recommend as an alternative that

the first course be laid 21 ft. wide the edge feathered off with the roller, the top course to be 20 ft. with the edge treated the same way. Either method we believe, will give satisfaction.

The specification further provides that materials upon reaching the road must all be placed on boiler plates and then shoveled by hand into position, mechanical spreaders, however, are also permitted. This year some of the contractors used what is known as the Burch spreader with good success. This spreader which is 8 ft. long could also be improved upon by changing into design to prevent the larger stones from running to the edge and to the center of the road, when half the road, or in our case ten feet, is being laid at a time. When the mechanical spreader is being used they are operated in pairs one slightly ahead of the other, this permits of traffic passing the spreader without hold up.

Each course as it is spread is thoroughly rolled with a ten or twelve ton roller until absolutely consolidated. The top course receives, however, just before final consolidation a coat of ⅜ in. chips, approximately 50 tons to the mile, but in any case, sufficient to fill all voids that appear in the surface. These chips are applied while the surface is still warm and are thoroughly rolled in during final consolidation. The road is then allowed to carry traffic for a period of from one to two weeks, after which a surface treatment of 60 per cent asphalt road oil, 1/3 gal. to the square yard, is applied.

When first considering the construction of this type of pavement we had in mind the application of a squeegee coat immediately following the placing of the top course, the intention being to use the same asphalt as used in building the pavement. The quantity of asphalt used, the slowness of application, and finally the non-uniformity of the surface appearance decided us to try the distributor method. We are still following this method with the exception that on one section we propose to try 80 per cent asphalt road oil. In any case, immediately following the surface treatment a second application of stone chips or pea gravel is applied, amounting to approximately 70 tons to the mile, the road is then completed.

It would probably be of interest to dwell for a moment before concluding on a few of the points that are outstanding in connection with the construction of this pavement. First, the equipment in the quarry, a crusher which will turn out 300 tons of stone per day, is required, next, the asphalt plant must be of sufficient capacity to handle this quantity of stone. On the road two rollers can be used to advantage, an eight ton and a twelve ton, equipped with scarifier. Mechanical spreaders assist materially in the spreading of materials; only five shovellers and two rakers being required to handle 300 tons per day. A foreman and one man to clean grade and remove forms complete the personnel. At the mixing plant itself, four men and one team will be required, with 22 men and four teams operating the quarry. The mix as it comes from the plant should contain 95.2 per cent stone, grading in size from dust to 2 in. ring and 4.8 per cent asphalt, penetration approximately 77. Where a stone is being used which is lacking in "fines" up to 5 per cent sand may be used to advantage, so far we have accepted any fairly well graded sand. The material should have a temperature of approximately 300°F as it leaves the plant in any case, arriving at the road at a temperature not below 275°F.

In the construction of a 20 ft. roadway, 6 ins. thick, 3700 tons will be required to the mile, where slight depressions in subgrade are likely to be encountered 10 percent must be added to this amount, or roughly 4000 tons of material are required per mile of road.

All contracts are let on a tonnage basis, the contractor supplying everything but the asphalt, which is supplied by the Department. This year the average cost per ton for the asphaltic mix laid down in finished road was $4.80 per ton or $19,200 per mile.

The work of constructing a mixed macadam pavement is still in the experimental stage; with each mile we completed we improved the type. There is no question but that time will tell whether we have succeeded or failed, but certainly the appearance of the road surface is all that could be desired at the present time. We have also pleased the thousands of motorists who have passed over the road and instead of the usual caustic remarks as to detours and inconvenience we have received many letters of commendation. Taking it all in all, we believe the type of pavement we have discussed will be an absolute success and anticipate the construction of a very considerable mileage next year.

USE OF UNCRUSHED GRAVEL IN ASPHALT HIGHWAYS

By Prevost Hubbard, Chemical Engineer, The Asphalt Association, 441 Lexington Ave., New York, N. Y.

(Address at 1926 meeting of Indiana Sand and Gravel Association.)

The speaker understands that at the present time there are some 200,000 miles of gravel roads in the United States and that approximately 33,000 miles have been built in the State of Indiana. The members of your organization have therefore apparently furnished approximately one-sixth of all the gravel used in gravel road construction in the United States or an amount equivalent to the average of any eight other states. The Association, which the speaker represents, is very much interested in the gravel roads of this country and of course in the very large mileage within the State of Indiana because it looks upon many of these gravel roads as being prospective bases for an asphalt pavement.

As you all know there are limitations to the economic life of plain gravel roads and when traffic reaches a certain intensity it becomes necessary to maintain the gravel surface with some sort of treatment usually with a bituminous material, such as road oil. Later as traffic becomes more severe a higher type of wearing course is required or one which is more resistant than the surface treated gravel road to the destructive effect of traffic. In such cases the dictates of economy can be effected by salvaging the old road as a foundation for a higher type of wearing course. The asphalt pavement is probably better qualified for such use than any other class of pavement and the slogan of the asphalt industry as developed at the Fifth Annual Asphalt Paving Conference held in Washington last month was "Conservation of Our Highways".

In order to salvage any type of road to best advantage, consideration should be given to the design of the old road which in some cases may be adequate to serve as a substantial foundation without appreciable modification or which may require some degree of reinforcement in order to make it sufficiently substantial to hold up the relatively expensive wearing course which is to be applied and keep it from failing under traffic because of weakness of the base.

Gravel roads which lend themselves most readily to adaptation as foundations are those constructed by the trench method which provides either a uniform thickness throughout their width or else a relatively slight change in thickness of cross-section. The speaker understands that in the State of Indiana the common practice in constructing gravel roads is to feather edge and he suggests for your consideration the idea of promoting the trench method of construction in future work. This will undoubtedly produce a longer life, lower maintenance cost gravel road, initially and at the same time will eventually provide a more satisfactory foundation for an asphalt or any other type of wearing course.

Apart from the salvaging of old gravel roads for asphalt wearing courses a very close relationship exists between the asphalt and the sand and gravel interests. Approximately one and one-half million tons of asphalt are used annually in the construction of asphalt pavements and conservative estimate would place the annual quantity of sand used in the construction of these asphalt pavements at not less than 10,000,000 tons. These figures represent wearing courses only. In addition, a very large amount of gravel is used in the construction of asphalt pavements but just how much it is impossible to estimate with any degree of accuracy.

Sand is almost invariably used as a fine aggregate for asphalt paving mixtures, while gravel must compete with broken stone and other products as coarse aggregate. Specifications recommended by The Asphalt Association permit the use of uncrushed gravel in all types of asphalt pavements with the exception of asphalt macadam in which an interlocking of the coarse mineral fragments is essential to the integrity of the wearing course. It is of course evident that angular fragments interlock to a much greater extent than do the more or less rounded pebbles of gravel but in asphalt paving mixtures stability may be secured not only by interlocking of the coarse aggregate but by packing the coarse aggregate with suitable void filling material. Specifications for asphalt paving mixtures take this fact into account and gravel is, and has in the past been, very extensively utilized as coarse aggregate, particularly for what are known as black base pavements. As a matter of fact gravel coarse aggregate is preferred to all others by some engineers, particularly in the far western states.

In a paper presented by Mr. Victor Nicholson, Engineering Chemist, Department of Public Works, Chicago, at the

Asphalt Paving Conference last month, the effect of shape of mineral aggregate grain upon the stability of asphalt paving mixtures was presented in a most interesting manner. The advantages of sharp grain sand were clearly developed but it was shown that in sheet asphalt paving mixtures proper packing of the sand with mineral filler tended to reduce the difference in stability obtained with sharp and round sands as the percentage of mineral filler was increased. The same rule undoubtedly holds true for coarse aggregates where sand and mineral filler combined may be considered to take the place of the mineral filler alone in fine aggregate mixtures. This fact undoubtedly accounts for the high degree of stability or resistance to displacement shown by many gravel asphalt paving mixtures.

In conclusion, the speaker would call your attention to a most important feature of our recent research work in connection with sheet asphalt paving mixtures which he believes will be of interest to you. As many of you know, the usual specification for sheet asphalt sand has been rather restricted insofar as grading requirements are concerned, and in many cases it is difficult to find a single sand which will meet the usually accepted standards of grading. To a considerable extent these grading limitations have been arbitrary and, while they have proved to be safe requirements no satisfactory theory has been evolved to substantiate their soundness. The Asphalt Association has developed a test for measuring the stability or resistance to displacement of sheet asphalt paving mixtures and as a part of the general investigation has been studying the effect of variations in sand grading upon stability. Indications so far secured point to the fact that while the present grading limitations yield satisfactory mixtures, many sands which do not meet these limits will also produce satisfactory mixtures. It is hoped to work out a satisfactory method of evaluating sands which will materially broaden our present restrictive requirements and will make available for asphalt construction many sands which are at present eliminated. In this way it is hoped to utilize to greater advantage local material and to make the furnishing of asphalt sands a less complicated matter to producers.

By these remarks the speaker does not wish to create the impression that grading limitations are not essential as it has been clearly demonstrated that low voidage of mineral aggregate is a most important consideration in securing paving mixtures of high stability, and voidage is a function of grading. It would seem, however, that there are many gradings which will produce low voidage which are now not included in our specifications.

WIDENING TRUNK LINES vs. BUILDING PARALLEL HIGHWAYS

By Ben H. Petty, Assistant Professor of Highway Engineering, Purdue University, Lafayette, Ind.

(Address at 1927 meeting of the American Road Builders' Association.)

With motor vehicle registration in this country increasing at the rate of approximately 13 per cent per year and the so-called saturation point still invisible, the question of either widening existing pavements or building parallel routes has become a major problem in thickly populated areas and will confront the highway officials of every state in the very near future. California now has approximately one motor vehicle to every three persons within its borders. Isn't it quite possible that within a few years the entire country may approach this degree of saturation? This would mean a total of some forty millions of vehicles, twice the present registration.

The problem covered by the subject of this paper is one that has developed largely during the past five years. In that period the registration of motor vehicles in this country has increased 100 per cent or in round numbers from 10,500,000 to 21,000,000. Increased registration naturally means increased traffic. The following table, showing results of traffic counts at eighteen observation stations in Massachusetts during successive three-year periods from 1909 to 1924, illustrates the great increase in traffic during the past few years:

Year	Average Vehicles Per Day	Per Cent Increase Over 1909	Per Cent Increase Per 3-Yr. Period
1909	270	------	------
1912	430	59	59
1915	760	181	77
1918	1180	337	55
1921	1950	622	65
1924	3721	1279	91

Similar results are shown by annual traffic counts on the Maryland state highways from 1917 to 1924 as indicated by the following table:

Year	Per Cent of Yearly Traffic Increase
1918	7.4
1919	28.2
1920	23.7
1921	22.3
1922	7.8
1923	25.4
1924	12.7

Highways Badly Congested

As a result of this great increase in motor traffic, highways which only a few years ago were entirely adequate, are today so badly congested that in some cases they are actually handling less than full capacity of traffic.

It is rather amusing now to recall some of the many criticisms hurled at those officials responsible for the ideal section of the Lincoln Highway constructed near Dyer, Indiana, about 20 miles south of Chicago, in 1922. The idea of a 40-ft. paved roadway in a rural district was considered preposterous by some and prophecies were made that traffic would never demand such a width of pavement. But already we have gone far beyond this limit in some communities with widths of 50, 60 and even 72 ft. of pavement on suburban roads.

A subject of this kind is more or less of a controversial nature and definite facts and figures supporting either side of the question are somewhat scarce. It has been the writer's plan in developing this paper to present some of the more noteworthy examples of both pavement widening projects and developments of parallel routs and then follow with some of the more convincing arguments both for and against each of the two plans for relieving traffic congestion.

Examples of Widening

Some of the more notable examples of pavement widening in various parts of the United States are as follows:

1. That part of the Boston Post Road running north from New York City across the state of Connecticut to New Haven is one of the heaviest traveled roads in the East. In an effort to relieve the serious traffic congestion, the Connecticut highway officials have started a program of progressive widening on that part of the road extending from the New York state line to New Haven. The pavement is being widened to 36 ft. providing 4 nine-foot traffic lanes.

2. The historic White Horse Pike extending 50 miles from Camden, New Jersey, to Atlantic City is being widened to accommodate the tremendous volume of motor traffic that pours into the famous seaside resort. The pavement is being widened by the addition of concrete shoulders. When the program is completed a paved width of 30 ft. will be available throughout its entire length. More than half of this widening was completed during 1926.

The traffic on this road has been greatly increased since the opening of the Philadelphia-Camden suspension bridge over the Delaware River. The highway forming the Camden approach to this bridge is being widened to a paved width of 76 ft. between curbs. W. S. Dean, State Highway Engineer of New Jersey predicts that this section of paved highway will handle over twenty million vehicles per year. This practically equals the total registration of motor vehicles in the United States at the present time.

3. During the last two years, the Lincoln Highway west of Philadelphia has been widened from 20 ft. to 40 ft. by building 10 ft. concrete slabs on either side of the old 20 ft. bituminous macadam pavement. This is termed a "dual type" pavement. Progressing further west from Philadelphia this total width is reduced to 30 ft. and finally merges into the standard 18 ft. pavement.

4. Michigan provides several examples of wide pavements. One of the most notable being the Detroit-Pontiac superhighway, known officially as Wider Woodward Avenue. This consists of a 204 ft. right of way carrying two 44 ft. concrete slabs separated by a 40 ft. car track section, thereby providing a complete separation of traffic in opposite directions. Kent County, has fixed 40 ft. as a minimum pavement width for future construction.

5. The Portland-Kittery highway, which is estimated as carrying 75 per cent of the tourist traffic into Maine, is being widened to 27 ft. by the construction of 9 ft. concrete slabs on each side of the present 9 ft. bituminous pavement.

6. In 1925 the Cahuenga Pass Highway leading out of Los Angeles to the north was paved to a width of 36 ft. Within a few months this width proved inadequate to handle the rapidly increasing traffic and during 1926 it was widened to a total paved width of 72 ft. This is one of the widest suburban, continuous pavements to be found in this country.

7. The biggest single program of

wider highways ever undertaken is now under way in Cook County, Illinois. The program will bring about the pavement widening to 40 ft. of 125 miles of main highways and the building of 247 miles of new 20 ft. pavements, in addition to widening shoulders, intersections and connecting city streets. A total of over 500 miles of streets and roads is affected at a cost of $32,000,000.

Du Page County, adjoining Cook County on the west, is planning three so-called super-highways extending east and west across the county. The plans call for 200 ft. rights of way with two 40 ft. pavements separated by a parkway and car track section 45 ft. wide. All other state and county roads will have rights of way of 100 ft. and 66 ft. will be the minimum for roads of lesser importance.

Arguments Favoring Wide Pavements

The arguments advanced in favor of widening our standard, two-lane, paved highways may be summed up as follows:

1. Providing more than two lanes for traffic reduces possible accidents due to attempts at passing around slow moving vehicles.

2. Three or more traffic lanes greatly increase the carrying capacity of a highway since the extra lanes permit fast traffic to pass around trucks and other slow moving vehicles, thereby raising the average speed of all vehicles using the road.

Arguments Against Widening

The following arguments may be advanced against the policy of widening our standard two-lane pavements.

1. It increases danger due to high speed on the adjacent inner lanes, the slow traffic being relegated to the outside.

2. Great expense is involved in securing the needed right of way for widening after adjacent property values have been greatly boosted by the construction of the original pavement. Almost invariably the paving of a highway brings about an increase of property values alongside. On roads leading out of our cities this increase may be manyfold in a reasonably short period of time. Buildings immediately spring up along such roads extending father and farther from the city resulting in almost urban conditions for several miles beyond the city limits.

3. Traffic congestion will be intensified at points where such widened highways pour their traffic into the cities or into other rural traffic arteries.

4. Adjacent property owners object to the multiplied noise and confusion incident to the greatly increased traffic carried by the widened pavement.

5. Construction difficulties due to necessary disruption of building lines and public utility installations as well as the expense and inconvenience incurred by the various companies involved in moving car tracks, pipe lines, pole lines, etc., argue against pavement widening in built up sections.

6. Widening pavements to form 6 and even 8 traffic lanes introduces multiplied difficulties at highway and street crossings. Cross traffic must be justly cared for. If uniform interval, stop-and-go signals are installed, the heavier traffic on the wide road is frequently delayed and the capacity of the road is greatly decreased. On the other hand, if non-uniform time signals are installed it may work an injustice on the cross traffic.

The Pedestrian Problem

In cities a serious problem is presented in getting pedestrians safely across the very wide streets. Some have suggested "islands of safety," spaced at regular intervals, across the street to aid pedestrians in a safe crossing. These islands bottle-neck the boulevard and greatly reduce its efficiency.

The apparent solution to this crossing problem involves the construction of either underpasses or overhead crossings so as to permit the traffic to use the widened pavement to its fullest capacity. Of course, this would involve enormous expense and would be quite impractical on highways having cross roads at frequent intervals.

Examples of Parallel Roads

To the writer's knowledge, there are very few examples of parallel highways constructed with the idea that they were to serve as parallel routes. It is true that there are some localities in which highways constructed some years ago, are, as a result of enormous traffic increases now functioning as parallel highways as we understand the meaning of the term. This is illustrated by the highways leading out to the west from Philadelphia. In addition to the Lincoln Highway there are three other state highways of major importance, lying to the south, which handle great volumes of traffic.

Similar conditions exist in the vicinity of Chicago. The new road program for Cook County provides for the construction of about 250 miles of new pavement

that will, in reality, serve as a net work of parallel routes for dispersing traffic. When completed there will be at least ten paved roads radiating out of Chicago to the northwest. These possibly could be classed as parallel roads in so far as the dispersion of outgoing traffic is concerned.

In Westchester County, New York, a parallel route to the Boston Post Road is being constructed and surveys are being made for a parallel route to the Albany Post Road. In addition the county is spending considerable sums in the building of fast traffic routes or parkways on which business traffic is excluded and the light or pleasure traffic is allowed to travel at the rate of 35 miles per hour. Grade crossings are eliminated so that there is very little interruption in the flow of traffic. These parallel routes are being constructed 36 and 40 ft. wide.

In the vicinity of Cleveland and other centers of unusually heavy traffic in Ohio a program of parallel highways is being carried out. In some cases this results in a boulevard system consisting of two 18 to 30 ft. pavements with parkway between.

Arguments for Parallel Roads

Those who favor parallel routes reason as follows:

1. Better dispersion of traffic is obtained which reduces congestion and probability of accidents.

2. The construction of parallel routes boosts real estate values along the new location, thereby increasing prosperity of the owners and providing greater resulting revenue from taxation.

3. As a rule, the right of way needed for a parallel route can be secured much more cheaply than the necessary right of way for widening an existing, over-loaded highway the original construction of which greatly increased property values alongside.

4. Paved road benefits and service are extended to more taxpaying units.

5. Makes possible the segregation of traffic by assigning truck and slow moving vehicles to one route and high speed traffic to an alternate route. By this plan the pavement carrying heavy truck traffic can be designed of an adequate thickness to safely withstand the action of the traffic, while the parallel road carrying the lighter traffic can be built thinner. Obviously this makes possible a considerable saving of taxpayers' money.

Arguments Against Parallel Routes

The following objections are pertinent to parallel routes:

1. Unless 3 traffic lanes are provided on each route, both will become inefficient due to slow moving vehicles setting the pace for all traffic in each lane.

A few years ago, at the time of a foot ball game at New Haven, the Boston Post Road became so congested by a mixture of slow and fast moving vehicles that the average traffic velocity was from 10 to 18 miles per hour. In order to speed up traffic, one of the division engineers with his assistants removed all trucks and "mopes" from the two-lane pavement and as a result the average traffic speed increased to 30 to 40 miles per hour. This indicates quite convincingly the value of segregating traffic where two-lane pavements are concerned.

2. It is doubtful if two parallel, two-way traffic roads with 20 ft. pavements will carry as much traffic as one 40 ft. pavement. On the latter, slow speed traffic can be forced to the outer lanes, leaving the center for high speed. In cases of unequal volumes of traffic in opposite directions the four-lane road can still be used to capacity while the two-lane road is inefficient due to danger in passing around slow traffic.

3. In general, the number of drainage structures will be multiplied, thereby increasing the cost as compared with the extension of existing structures when pavements are widened.

4. The number of railroad grade crossings would be increased in many cases.

A Wisconsin Parallel Road

A rather interesting situation has arisen in connection with a parallel road development in Wisconsin. State Road No. 19 paved to a width of 18 ft. from Milwaukee to Madison is one of the most important roads in the state. A peak traffic count on this road recorded 17,000 vehicles in 24 hours. It is estimated to carry an average daily traffic of 6,000 vehicles throughout the entire year.

About five years ago the state highway officials of Wisconsin conceived the idea of building a parallel road one and one-fourth miles south of Road 19 to relieve the serious congestion. This parallel road was so located as to lead directly from Waukesha, a city of 15,000 population, to Milwaukee, entering the latter on National Avenue, which is one of the principal streets on the south side. The high daily traffic count taken on Road 19 the year previous to the building of the parallel road was 11,500 vehicles. The first year the new road was opened it carried a maximum daily traffic of 5,500

as compared to 13,600 on No. 19. Traffic has increased more rapidly on the old road than on the new, culminating in a maximum of 17,000 vehicles in 1926, as compared to 8,500 on the new road.

This illustrates the fact that some roads, due to certain strategic advantages in location, must continue to carry traffic that will not be diverted to parallel routes. In such cases widening is not only justified but absolutely necessary. Wisconsin plans to construct a 40 ft. pavement a few feet to one side of the present 18 ft. slab on No. 19 and install one-way traffic regulations. Eventually this highway will consist of two 40 ft. pavements separated by a 30 or 40 ft. parkway.

Discussion

Our great handicap now, where widening is desirable, is the lack of sufficient rights of way. Great sums of money could be saved to the taxpayer if those who planned our present street and road systems had only possessed the foresight to vision the present traffic and have provided sufficient rights of way to permit widening of pavements as necessary. It is rather presumptuous for us to blame our predecessors for this condition unless we clear ourselves of future censure by securing, at once, on our present roads, adequate rights of way to care for traffic increases for several years to come.

It has been proposed that highway officials adopt the policy of securing at once sufficient rights of way to care for the maximum practical future width of pavement. This would prevent the erection of buildings so close to the road that they would have to be moved later when pavement widening becomes a necessity. The excess land not used for present traffic could be leased back to the farmers for cultivation until needed for roadway purposes.

Providing Park Space

In constructing wide pavements of four or more traffic lanes, it is desirable from the standpoint of safety to provide a park space at the center to entirely separate traffic moving in opposite directions. On wide pavements, slow traffic will naturally be crowded to the outer lanes, thus throwing the high speed traffic in close proximity at the central lanes. Considering the many careless, incompetent drivers on the roads today in addition to the dangerous "hip flask" drivers, it is quite evident that the park space separator is justifiable.

There is one handicap due to this park space that should be pointed out. Traffic flow in opposite directions is seldom equal. For example, the traffic is usually greater toward cities in the morning and away from cities in the evening. The park space in a case of this kind would cause one-half of the pavement to be overcrowded, while the other half might be quite free of traffic. Where no park space is present, the denser traffic can spread out onto the unused lane or lanes of the other half of the pavement. While this may increase traffic hazards, it nevertheless utilizes the full width of the pavement.

Between Seattle and Tacoma plans have been prepared for a wide highway consisting of two 20 ft. slabs of concrete separated by a 4-ft. gravel strip. This will tend to separate opposing traffic, but by providing a graveled crossover it will still permit full utilization of the entire pavement during periods of unequal traffic flow.

Conclusions

The majority opinion of highway engineers and officials consulted by the writer considers 40 ft. as being the maximum desirable continuous width of pavement for our heavily traveled highways. Where this is not adequate for the traffic, parallel routes (not necessarily within a mile or two of the road involved) should be developed to handle the excess.

The following quotations are from the report of the "Committee on Highway Traffic Analysis" of the Highway Research Board rendered in December, 1925: "Investigations indicate that the 20-ft. roadway is of ample width to provide adequate clearances between the sides of vehicles and the edges of the roadway, and between passing vehicles."

"The Committee concludes that 22 and 24 ft. roadways are not required for two lanes of traffic" . . .

. . . "The illustrative data submitted indicates that roadways of from 24 to 30 ft. in width are used as three-lane, two-way roadways. Unfortunately, however, traffic movements on the middle lane cannot be goverened by a right-of-way regulation. Hence the use of three-lane roadways provides conditions under which accidents may frequently occur. The Committee, therefore, from the standpoint of encouraging design which will promote the safe utilization of highways, recommends the use of the four-lane roadway when the highway transport survey

indicates that the traffic capacity of a two-lane, two-way roadway will be exceeded."

Bottle Neck Elimination

Widening should not be considered until all bottle necks and other obstructions have been eliminated and adjacent roads are receiving their fair share of traffic. A two-lane pavement should reach a peak load of approximately 2,000 vehicles per hour of unsegregated traffic before being widened.

Justification of wide pavements should not be considered on the basis of constant efficiency. There are bound to be slack periods of traffic on our superhighways which is also true of our standard two-lane roads. Peak traffic should be the governing factor.

The writer believes that pavement widths up to 40 ft. are necessary and are the best methods of handling excessive traffic in many communities. However, the parallel road has its place in the dispersion of traffic and in the opening and development of more rural areas. Each specific problem requires individual study to accomplish its proper solution. No general rules can be laid down to cover all cases.

Expenditures Demand Consideration

Highway officials should not be carried off their feet by the noisy insistent demands for excessive expenditures on pavement widening programs in certain localities resulting in very unfair concentration of highway expenditures in a few districts to the neglect of just demands from other parts of the state. Actual traffic conditions as determined by a state-wide highway transport survey such as those conducted in Connecticut, Massachusetts, Pennsylvania, Ohio and also in Cook County, Illinois, should form the basis of plans for relieving traffic congestion. Only in this way can our highway funds be expended intelligently for this purpose.

We are not confronted by a theory but a reality. Traffic congestion is already threatening the progress of many communities. It behooves the responsible public officials to attack this problem promptly and with the necessary courage and determination to carry out the plans which, from proper consideration, appear to provide the best solution of the problem. Such plans may appear exceedingly ruthless to certain more or less powerful groups and therefore a backing of earnest public opinion should be developed to carry the plans to maturity.

EARLY PAVING OF ILLINOIS, PRIMARY HIGHWAY SYSTEM REQUIRES ADOPTIOI OF THE GASOLINE TAX

By Samuel C. Hadden, Editor "Municipal and County Engineering."

(Address before Mattoon, Illinois Association of Commerce, Jan. 3, 1927.)

The early completion of the Illinois system of primary State Highways is dependent on the enactment of a gasoline tax law by the Illinois State Legislature at its present session. With funds now available, and to become available under present laws, these roads can all be paved by the year 1943. However, if present funds are supplemented by the proceeds of a 2 cent gasoline tax, these roads can all be paved by the year 1933. So that we may face the question squarely, let us put it in this form: "Shall we detour for another six years or for another sixteen years?" The speaker is confident that the people of Illinois will expect their representatives in the Legislature to pass a law, levying a tax of 2 cents a gallon on gasoline, so that the traveling public in this State may emerge from the detour era in the year of grace and mercy 1933.

Facts in the Premises

Let us examine the facts in the premises. The Illinois Division of Highways recently placed under contract all of the remaining mileage of pavements on the $60,000,000 bond issue system, with the exception of those projects where engineering difficulties made it impossible to do so. The Attorney General of the State has given his official opinion that the Highway Division may now go ahead legally with the $100,000,000 bond issue roads. Contracts for pavements on these roads will be awarded from time to time this winter and spring, and it is expected that at least 1,000 miles of new pavement will be constructed under these contracts in 1927.

The question of the future financing of the State road program has become one of great importance. If the second bond issue system is to be completed within a reasonable time, additional funds must be provided. The most equitable method of securing this additional revenue is from the proposed gasoline tax. Such a proposal may well be regarded as conservative, rather than radical, as gasoline tax laws are now in operation in 44 states and the District of Columbia.

As a necessary preliminary to an in-

telligent consideration of the need for the proposed additional revenue, the true status of Illinois State Highway finances must be understood. When the second State Road bond issue was being considered, Governor Small recommended to the General Assembly a bond issue of $100,000,000 to be paid, principal and interest by automobile license fees, and to be used for the completion of the $60,000,000 bond issue system and to add to it approximately 2,500 miles, or sufficient roads to bring the total State road system up to between 7,000 and 8,000 miles. The Legislature passed a bill providing for a $100,000,000 bond issue, but acting entirely within its rights and powers, increased the total by approximately 2,500 miles without providing any increase in the bonds to be issued. This law was subesequently ratified by the people, by a 3 to 1 vote.

Now there has already been used approximately $29,000,000 of the bonds of the $100,000,000 issue for the completion of the $60,000,000 bond system, and about $16,300,000 more will be required for this purpose or a total of $45,300,000 of the $100,000,000 bonds, to complete the $60,000,000 system of highways.

A carefully proposed budget of the Illinois road program, as revenues stand today shows that the last of the bonds of the $100,000,000 issue will be sold by the end of the year 1929, and approximately 2,500 miles of the $100,000,000 bond issue system will have been completed by that date, leaving about 2,500 miles unfinished. With no additional revenues available, the construction program after 1929 will be limited to about 200 miles per year, and it will take until the year 1943 to finish the 9,800 mile system contemplated in the second bond issue law.

However, if a 2 cents per gallon tax on gasoline is adopted by the State at this time, it will yield at least $9,000,000 per year, and this amount will gradually increase with the increase in the number and use of motor vehicles. This revenue if devoted entirely to the completion of the State bond issue system, together with the unsold bonds, Federal Aid funds, and surplus motor license fees, will complete approximately 3,300 miles by the end of 1929, and the remainder of the $100,000,000 bond issue system by 1933, or ten years earlier than would otherwise be possible.

It is felt that the people of Illinois are entitled to the early completion of the primary road system for which they voted and that it would be unfair to the motorist to jeopardize this completion by diverting revenue derived from motor cars to any other purpose, however good, until this major purpose has been accomplished. The advantages to the public by having this superb State Highway System ready for unobstructed use in 1933, instead of 1943, are too numerous, too obvious and too well understood to permit of enumeration.

After the bond issue system of 9,800 miles has been completed, it would seem to be advisable next to connect up approximately 160 incorporated cities and villages not now on the projected system. After that has been accomplished, Illinois will have an adequate State Highway System and any surplus revenues from motor vehicles, after the principal and interest payments on bonds and an adequate maintenance fund have been taken out yearly, may well be used in the improvement of a secondary road system.

The Gasoline Tax in General

Having indicated the need for additional revenue for State highways in Illinois, and having recommended the enactment of a 2 cent gasoline tax for that purpose, the speaker would like to call attention to the fundamental soundness of a tax on gasoline for highway purposes and to tell something of the present status of gasoline taxation throughout the country. Attention will be called also to the very satisfactory experience of the neighboring State of Indiana with this method of raising money for highway construction and maintenance.

The first gasoline tax law enacted in this country was that adopted in 1919 by the State of Oregon. Prior to that time many students of the problem of highway finance had suggested a tax on gasoline as at least a partial solution of this important, but difficult, problem. Following the lead of Oregon, within the very short period of 7 years, 43 other states and the District of Columbia have enacted similar laws. This fact alone is strong presumptive evidence of the fundamental fairness and soundness of gasoline taxation for highway purposes and of its widespread popularity. In fact, the gasoline tax is a hitherto unheard-of thing: it is something new under the sun; it actually is a popular tax! Even conservative little Rhode Island, which never ratified either the woman's suffrage or the prohibition amendments to the Federal Constitution, has embraced the gasoline tax.

Since the dawn of recorded history, the human family has complained bitterly of

any and all forms of taxation and we read of many ingenious methods of levying taxes and of even more ingenious methods of avoiding their payment. For example, it is said that at one time in England a tax was levied on windows in houses, the more and the larger the windows, the higher the taxes. To avoid the consequences of this tax, the house-builder cut down on the number and size of windows, built concealed windows and even omitted them entirely. And so the taxpayer and the tax levying official have played hide-and-seek throughout the ages. Perhaps the limit was reached when a tax was placed on the renowned fig trees of Egypt. The owners of the trees cut them down to avoid payment of the tax. After all the heartburnings and bloodshed engendered by taxation throughout human history, it is distinctly encouraging to observe that at last a tax has been found which the great majority of people pay, not only willingly, but gladly.

Since the gasoline tax affects alike the just and the unjust, the rich and the poor, in proportion to benefits received, it appeals to man's innate sense of fairness and square dealing. Since almost every family now has some sort of motor vehicle, and as each vehicle must use the highways, every fair-minded man admits that this car should be taxed for the construction and maintenance of the highways it wears out. Moreover, almost every man will admit that payment should be in direct proportion to benefits received. The more a motorist uses the highways, the more he should pay, and the most exact and convenient method of measuring the use of the road is by the consumption of gasoline. Gasoline consumption not only measures the distance traveled, but it reflects, to a considerable degree, the speed of travel and the weight of the vhicle and its resulting destructive action on the road. In fact, the gasoline tax is a measured, or metered tax, and selling highway use by this method is now fully as well established as selling water, gas or electricity by meter.

But desirable as the gas tax is, taken by itself, it leaves something to be desired. In charging for our highways we must again parallel the practices of the water, gas and electrical utilities. There must be a "readiness-to-serve" charge. That is since our roads are necessarily rendered more expensive by reason of high speed and great weight of vehicle, it seems fair and reasonable that this well known fact should be reflected in the amount of the license fee assessed against any vehicle. The higher the horse-power and the greater the weaght, the higher the license fee should be. If a man has a high-speed car or a heavy car or truck, even if he uses the roads only occasionally, they are there, or will soon be there, when he wants them. In other words, the roads are "ready to serve" his fast or heavy vehicle when he wants them, even if that is not often. This fact not only calls for, but justifies the "readiness-to-serve" charge, or license fee. The gasoline fee ideally and equitably supplements this "readiness-to-serve" charge and imposes a charge for extended service in very direct proportion to service rendered.

One of the most appealing attributes of the gasoline tax is that it provides a method whereby the tourist is automatically charged for the use of the highways when he travels any considerable distance outside of his home state. This feature will doubtless appeal strongly to Illinois motorists, for Illinois is entirely surrounded by gas tax states. People from surrounding states pay nothing for the use of Illinois roads, but when the Illinois motorist leaves home he has to pay as he goes for the use of the highways. By failing to have a gas tax law, Illinois is losing millions of dollars annually that such a tax would levy on tourists and which the tourists would gladly pay.

Another feature of the tax under discussion, which contributes greatly to its popularity, is that it is paid a little at a time, on the installment plan. This humane feature makes the tax comparatively painless. In fact, if the oil companies did not post the tax conspicuously at all filling stations, the average citizen would never know he was paying such a tax.

Speaking of the oil companies, let it be recorded that after their fears of lessened sales, due to the tax, proved groundless, they have offered little open or covert opposition to the tax. In fact, the cooperation of these great and splendid companies has not only facilitated the administration of gasoline tax laws, but has materially lessened the cost of collecting the tax. In any state where the law is properly drawn and administered, the cost of collection should always be very much less than 1 per cent of the revenue produced by the tax.

Constitutionally, the gasoline tax is sound. It has been tested repeatedly in court and has always safely withstood the test.

In almost every state where a gasoline

tax has been proposed it has been bitterly contested by motor club officials. We say "officials" for that is what we mean. The average motorist has never been very hostile to the idea, even in the absence of experience, but the motor club official, trained and accustomed to fight any and all forms of motor vehicle taxation and profiting personally from such opposition, has seldom failed to do his little damnedest to defeat the gas tax. That his opposition has been futile, even thogh extremely troublesome, the widespread adoption of the principle most eloquently attests. Let me hasten to add, however, that some motor club officials, sensing the essential fairness of the tax, have openly aided its enactment and have suffered no injury at the hands of their club members from this beneficent and enlightened labor. The average motorist, everywhere, has responded to the gas tax as if he considered it an appeal to his intelligence.

Indiana Experience

When the speaker first took up the study of the gasoline tax in 1922 preparatory to the 1923 session of the Indiana Legislature, at which the Indiana gas tax law was enacted, he found the experience of other states with the tax most helpful. Thinking Indiana experience may be of similar help to you, I shall give, very briefly, some of our most significant experience with the tax.

The chief criticism advanced against the tax, before it was enacted, by its opponents, was that the cost of collection would be very high. Estimates of the cost of collection, as computed by opponents, ranged all the way from 10 per cent to 50 per cent. What has experience demonstrated in this important particular? The cost of collection has never exceeded one-eighth of 1 per cent.

Most of the opposition came from motor club officials, who put out some very misleading and one-sided propaganda. These officials have long since admitted their mistake in this matter, and some of them are as proud of the measure as if they had fathered it. The average citizen is so thoroughly sold on the tax and its good features that he talks as if he had conceived the idea of the tax in his own mind.

A few members of the Indiana Legislature of 1923 strongly opposed the enactment of the proposed law. They continued this opposition for a time after the law was enacted, but perceiving that they had no considerable popular following, they dropped their opposition, and when the Legislature of 1925 met, hardly a voice, and that but a feeble one, was raised in protest against a tax that the public had obviously and overwhelmingly approved.

In Indiana the gasoline tax is solely a road users' tax. It is not a commodity tax or a sales tax, but is a fee for the use of the highways. In fact, while I have said much about the Indiana gas "tax", the word "tax" does not appear at all in the statute. It is called the "'gasoline fee law," and not a gasoline tax law in the law books, court decisions, etc. I have used the word "tax" colloquially only. Let no one suppose that this was a polite fiction used to beguile the public. It may be easy to beguile the native Hoosier on some subjects, but he is alertness personified when a raid on his pocketbook is in prospect. The Indiana law very specifically limits the application of the "fee," or tax if you please, to gasoline or other motor fuel used in the propulsion of motor vehicles over the highways of the State. All other uses of gasoline for any purpose whatever are exempted from payment of the fee. The fee is on the use, and not on the purchase or sale of the gasoline, and after a man has used it for any other purpose than the single purpose the law contemplates, he can file a claim for a refund with the Auditor of State, and the fee he paid is refunded to him promptly and in full.

The amount of money collected under the Indiana law has alwayes exceeded expectations. When the 2 cent fee law went into effect on June 1, 1923, its principal advocates estimated that it would yield $3,000,000 in its first full year of operation. This estimate turned out to be over-conservative, as a total revenue of $4,554,544.18 was produced in this period. Knowing the number of vehicles in the State and the national average of gasoline consumption per vehicle, it was easy to estimate the purely Indiana revenue, but there was no way to estimate the tourists' highly prized contribution to the fund. It is evident from the figures quoted that the tourist contributed much more than was anticipated.

It will be remembered that the Indiana fee is not a commodity tax, not a tax on gasoline, but merely a tax on the use of the highways as measured by the consumption of gasoline. For this reason, all users of gasoline other than for the propulsion of motor vhicles over the highways, are exempted from the payment of the tax by the law. On gasoline so

used, it is necessary to file claim for a refund of the tax paid. Many thought that refunds so secured would cut heavily into the tax. During the first year the law was in operation the refunds made amounted to $73,927.61, or 1.6 per cent of the total revenue collected.

In Conclusion

So that no one will conclude that the speaker, a resident of Indiana, is showing an improper interest in an Illinois problem let me say that I am merely returning home with a message. The speaker is a native of Illinois and a graduate of the University of Illinois, two facts of which he is proud. His family has paid taxes in this State since 1860. Nearly all of his relatives and many of his friends reside in this state, and he would not advocate a measure that would be other than a blessing to them.

With the backing of the Governor and the highway officials of Illinois, and with the collateral support of its unqualified success elsewhere, there is every reason to suppose that the 1927 session of the Illinois General Assembly will enact the proposed 2 cent gasoline tax into law. I would advise civic bodies and Chambers of Commerce to give the measure their ungrudging support. Here in Mattoon you are interested in one of the proposed new State Highways. I would imagine it would expedite the paving of this highway if the people of this community would extend to the Governor and State Highway Officials the support they deserve and desire.

The proposal is meeting with gratifying response in many parts of the State. For example, Champaign County has circulated a map of that county, bearing the following imprint:

"Should Illinois Have a Fair and Just Gasoline Tax? 44 States Have Such a Law. We congratulate Governor Small, Director Miller, Engineer Sheets and the experts associated with them for studying the relationship of a tax on gasoline to the Illinois hard road problem.

These men look into the future.

Study with them this important subject that 44 states out of 48 have accepted as something worth while.

Literature on this subject will be available from time to time. Read it carefully and get all the facts.

Published by
Champaign County Boosters
for Good Roads."

Conclusion

The speaker is familiar with Illinois highway problems. He believes that the early paving of the primary highway system requires the adoption of the gasoline tax. Speaking from this knowledge and belief, he does not hesitate to advise the forward-looking citizens of Illinois to urge their representatives in the General Assembly to vote for the proposed tax on gasoline for State highway purposes.

WHAT NEW YORK MUNICIPALITIES ARE DOING

(From the Bulletin of the New York State Bureau of Municipal Information.)

Jamestown has abandoned the plan of abutting property owners paying for water main extensions. Further extensions will be financed out of the profits of the municipal water department.

Olean has passed an ordinance regulating new subdivisions within city limits. The ordinance prohibits any firm or corporation from offering or advertising land for sale and represented as plotted into streets unless a map showing such streets has been filed and approved by the city engineer.

Buffalo is preparing an ordinance relating to the sale of materials obtained from refuse. From the sale of waste paper alone the city received $55,000 last year.

Poughkeepsie has passed an ordinance prohibiting auction sales of jewelry between 6:00 P. M. and 8:00 A. M.

A new ordinance permitting auction sales up to 6:00 P. M. was vetoed by the mayor of Elmira. The former regulation prohibitetd sales after sunset.

The common council of Gloversville has approved a regulation permitting physicians to place "no parking" signs in front of their offices.

Buffalo's natural gas wells costing $53,951 have so far yielded gas valued at $72,327 and are still producing.

Salt Lake City has an ordinance which prohibits any city employee under civil service from membership in or affiliation with any organization or society, the object, purpose, practice or operation of which shall either directly or indirectly interfere with or challenge the discipline or conduct of such departments by lawfully constituted officers.

Chicago has prepared an ordinance requiring building inspectors, plumbing inspectors, street inspectors, sidewalk inspectors, sanitary inspectors, policemen, firemen and any other city employees whose duties are of a patrol nature, to make a diligent, non-technical inspection

and observation of streets, sidewalks, alleys, lots, yards, buildings, etc. in addition to the performance of their regular duties. In Schenectady the firemen have for some time been sanitary inspectors.

Rockville Centre has designated one street as a "fire street" on which the parking of vehicles is prohibited.

Buffalo has passed an ordinance prohibiting the rendering of dead animals within the city limits.

The common council of Jamestown has voted to put members of the fire department under the provisions of the New York State Retirement Fund.

Syracuse is planning to extend its automatic traffic signal system to boulevards.

Little Falls has passed an ordinance to submit to a referendum the question of eliminating grade crossings.

Amsterdam's common council has made formal demand for a five cent trolley fare.

Beacon is revising its traffic and parking ordinances. Right turns while automatic traffic lights are red or yellow have been banned by ordinance.

The framers of the new charter of Auburn have asked the council to drop the new assessment plan.

The Syracuse Bureau of Water is now locating and planning to eliminate all cross connections between the city water supply and other water supplies.

The city council of Glen Cove has made an offer for the purchase of a water plant operated by a private company.

The sale of dipped milk is now prohibited in the city of Syracuse.

CAUSES OF SUCCESS AND FAILURE OF BITUMINOUS MACADAM PAVEMENTS

By Squire E. Fitch, Superintendent of Highways, Chautauqua County, Jamestown, N. Y.

(Paper read before the Fifth Annual Asphalt Paving Conference, Washington, D. C., November 8-12, 1926.)

From 1910 to 1922 I was employed in various capacities by the New York State Highway Department. The last three years of this time it was my duty to inspect, make reports upon and recommendations for the maintenance of more than half of the State road systems. In this work I consulted with the engineers who built and maintained these roads and I learned a great deal about how bituminous roads should, and should not be, built.

I believe it is generally conceded that Rhode Island has built about the best bituminous macadam roads in this country. New York State, in years past, built some that were good and some that were not so good. Of course the roads that received the most of my attention as a maintenance engineer were the ones that for one reason or another were not satisfactory. Mr. Henderson has already told us how Rhode Island builds her successful bituminous macadams. Logically the thing for me to do is to tell how not to build them.

Bituminous macadam roads have been much maligned, so, first of all, I want to say a few good words for them and explain how some of this maligning came about, particularly in New York State.

New York has 30 percent of all her roads improved, and that means she has enough hard-surfaced roads to reach around the world. She has 6,500 miles of bituminous macadams alone, and that is 36 percent of all the bituminous macadam in the United States. About half of these were built by the State; most of them between the years 1908 and 1914. It was during this period that a large percentage of all improved roads were built of three types: waterbound macadam, second class concrete, and bitminnous macadam. Mistakes were made in the manner of building all of these types. With the coming of heavy motor traffic the waterbound roads began to wear out very quickly, sometimes, indeed, in one year. To stop this wear New York State gave them a generous application of heavy, hot, asphaltic oil. This stopped the wear all right, but formed a thick mat, which, of course, bunched up in great gobs and made the roads so rough that it seemed as though they never would wear out.

The second class concrete roads were built by taking a large quantity of water and mixing with it one part of Portland cement to 6 parts of dirty, run-of-bank gravel. Sometimes the pits produced mostly all sand, sometimes nearly all pebbles; always a large part of the cement was washed away by excess water.

The asphaltic macadams were built in various ways; some were well built. Many of them were hand-poured. Some were rolled too much prior to the first pour; some were rolled in wet weather so the mud squeezed up between the stones, preventing a good penetration of asphalt. Sometimes too much seal coat was used. Sometimes the asphalt was of good quality; sometimes it was not so good. Always in the early days the specifications

permitted asphalt of too soft a grade—150 to 200 penetration. Is it any wonder that some of these roads bunched up like an immense washboard?

With the vast mileage I have told you about, with the common lack of knowledge in that day of how to build such roads, with politically appointed inspectors and with the lax inspection prevalent prior to 1913, is it any wonder that New York State had some unsatisfactory roads? Now whatever any one may think of modern first-class concrete roads today, I never heard anyone condemn them simply because those old 6-in. second-class concrete roads, built as I have described, were not satisfactory. In this respect bituminous macadam has not been so fortunate. Its reputation suffered greatly in consequence of these early mistakes. It has suffered not only for its own sins, but also on account of the shortcomings of waterbound macadam. The layman cannot be expected to distinguish between a bituminous macadam road and a surface-treated waterbound road. Not a little prejudice against bituminous macadam has been caused by the rough surface of a gobbed up mat on top of a waterbound road. Wherever their foundation was good most of these old macadam roads were durable enough but some of them were so rough and disagreeable to ride over that may people believed they were altogether too durable. This disagreeable roughness created a prejudic against black macadam roads which has never been eradicated. Today engineers know how to build a bituminous macadam road that will remain smooth.

These are some of the reasons why I say that bituminous macadam is a much maligned pavement. Some engineers will tell you that the cost of maintaining bituminous macadam is high. On the face of New York State reports, their maintenance cost does appear high. The average cost of maintenance of the asphaltic penetration roads in New York in 1925 is given as $1,010 per mile. Surely this is high, but, even so, it is less than her maintenance cost of second-class concrete built about the same time. They cost $1,141 per mile. It must be kept in mind, when using these maintenance figures, that they cover very old roads, built in the manner described, and also that 30 percent of New York State roads built prior to 1914 were only 12 ft., 14 ft., and some even less than this in width. The figure of $150 per mile for maintenance of bituminous macadam roads built in Rhode Island since 1914, is very interesting. It is more nearly what we can expect of modern work and I believe may be fairly compared with the cost of maintaining first-class concrete roads in New York. They also have been built since 1914. In 1925 their maintenance cost was $174 per mile. I believe they are fairly comparable both in age and amount of traffic.

For the past three years I have been building bituminous macadam roads for Chautauqua County, and I have endeavored to apply the principles I learned while I was with the State. If these Chautauqua County roads remain as smooth and have as long a life as I expect them to have, it will not be on account of any startling new methods of construction that I have discovered. On the contrary, it will be because of the actual application of as many as possible of the well-known principles that engineers have worked out in the past decade.

The methods of construction that we use do not differ much in the essentials from those used in Rhode Island. The cross-section of our pavement is considerably different. Our roads are too new to have such a long, successful record to point to, as have those of Rhode Island. Nevertheless, I have every confidence in them and will therefore tell you, as briefly as possible, how we build them.

Our roads have considerable traffic but are not on the main thoroughfares; consequently we build them but 16 ft. wide. In place of being only 8 ins. in thickness, as are the Rhode Island roads, we build them 18 ins. or more in thickness; never thinner than that.

The average cost of our pavement is $18,000 per mile and that is not greatly different from the cost of Rhode Island roads. Grading, culverts and miscellanous items bring the cost of the complete road up to $22,000 to $23,000 per mile. Occasionally a soft local sandstone, with a co-efficient of wear of about 7, is available in ledges, but generally no local materials are available except a poor quality of bank or creek gravel. Crushed limestone and slag are shipped in from Buffalo, some 70 miles distant. Where the hauls for imported stone and slag are long and the local soft stone is available, it can be used, and we do use it for both bottom and top course, but if so used for top course it should be screened to larger sizes than hard stone. We use sizes between 1¾ and 3¾ ins. The tailings and small sizes can be used to excellent advantage for a bottom course.

The tailings will readily crush up under the roller and the small sizes make an excellent filler to add while rolling. Where this soft stone is used for top stone, we run the roller over it not more than once or twice prior to making the first pour of asphalt. This is to prevent its crushing up by the roller into sizes too fine to give good penetration of asphalt. The key stone and chips can be made to take the wear by using a slightly greater quantity than usual, with a heavier seal coat. The key stone and chips should be of good, hard stone, even if necessary to import them. We find no difficulty in getting any size of local crushed stone we desire by the proper selection of screens. Where the difference in cost is not too great, I prefer to use a good quality of stone throughout the top course because both construction and maintenance will require more care when soft stone is used. A good mat must always be kept over the road to prevent wear coming on the soft stone.

We use 12 ins. of run-of-bank gravel for a foundation on the entire road. We use 5-ton trucks for hauling gravel and they will quickly show up any weak spots in the road, better than a 10-ton roller. Where such spots are encountered, or expected, we at once put an extra course of gravel over these spots and haul the rest of the gravel over it. If this does not strengthen it enough, we add another layer of gravel until the road is firm. We then put the regular two 6-in. courses of gravel on top of it all, raising the grade line where necessary. The gravel is loaded on hired trucks by steam shovels. It is spread with mechanical spreaders, rolled with 10-ton rollers, continually smoothed up with small one-man graders built around Fordson tractors. From 300 to 600 cu. yds. is put on per day at an average cost of a little over one dollar per cu. yd. in place, or $4,000 per mile.

We prefer to let the gravel stand over winter before putting on bottom and top courses, but usually this cannot be done. When this gravel foundation is firm enough to hold up loaded 5-ton trucks withoiut movement, we lay a 4-in. loose or a 3-in. consolidated bottom course of slag crushed between 2½ and 3¾ in. sizes. We roll the slag thoroughly, adding slowly a fine dirty gravel for filler. This bottom course also costs $4,000 per mile. When this is as firm as a water-bound macadam, we lay a 4-in. loose or 3-in. compact course of crushed limestone, poured with 1¾ gals. of 110 penetration asphalt, keyed with ¾ to 1¾ in. limestone. For a seal coat we use ½ gal. of asphalt and I prefer to have this seal coat of 150 penetration. Limestone chips, and plenty of rolling and back-rolling, completes the operation.

We keep our costs down by doing the work with county forces, by using modern machinery, and by avoiding hand labor wherever possible. I know many of you are skeptical of it myself. I know what you are thinking about my overhead not being included in the costs. It is so included but I haven't time to go into the question of departmental work here. I will confine myself to saying if your department is as free from political influence as ours is, a good departmental organization, if not too large, can save money over contract work. Don't try it though unless you are free to hire and fire whom you please.

Our excavation is done by steam shovels, supplemented by trains of four 1¼-yd., self-loading scrapers pulled by 10-ton caterpillar tractors. The fine grading and most of the trimming is done by one-man blade graders built around Fordson tractors on crawlers. Our stone and slag is unloaded by mechanical unloaders into bins. All gravel, stone and slag is hauled by hired trucks paid for on the cubic yard mile basis. The price varies for hauling each material on each road and is established by a diagramatic chart which is so drawn that a Liberty truck can earn $3 per hour provided it loses no time. By hiring trucks in this way we avoid paying for lost time. This is better than letting a contract for the hauling because we can put on as many trucks as we please and can weed out the poor ones which detain the others.

We spread our stone, slag and gravel with mechanical spreaders. Each truck carries its own chains, hitched on and adjusted so that the chains are the proper length to drop the hooks into the rings of the spreader.

We pour asphalt with motor distributors. Just prior to pouring we blow out the nozzles and manifold with live steam conducted through a steam hose from the roller to a tap which we have installed between the tank and manifold. This cleans out and heats the pipes and nozzles before the distributor starts. To avoid having the truck wheels of the distributor make ruts in the top course by their tractive pull, we pull the truck with a steam roller for the first pour and adjust the governor of the roller to give the exact speed desired. We try to make each succeeding course smoother

than the one below. We agree that it is impossible to build a smooth top on a rough, uneven bottom course.

These roads ride well and I believe will last as long or longer than many roads of other types that cost nearly twice as much. My reason for thinking they will have a long life, aside from the fact that we take pains in the details, is on account of the thickness of the pavement.

The main points of difference between our roads and those of Rhode Island are as follows:

The standard thickness of Rhode Island roads is 8 ins. plus the extra foundation under soft spots.

Our roads are 18 ins. thick plus the extra foundation under weak spots.

The Rhode Island top course is 2½ ins. thick while our is 3 ins. thick.

The Rhode Island bottom course is 5½ ins. thick while ours is but 3 ins. thick.

Rhode Island uses 2½ gals. of asphalt of 85 to 100 penetration on a 2½-in. top course.

We use ¼ of a gal. less per sq. yd. on a top course ½-in. thicker. We do it by reducing the seal coat to ½ gal. We use asphalt of 100 to 110 penetration.

Inasmuch as bottom course is cheaper than top course and 2½ ins. of top seems to be satisfactory in Rhode Island, it would seem that we might save a little money and not sacrifice strength by increasing our bottom course from 3 ins. to 4 ins., and reducing the top course from 3 ins to 2½ ins. I am also willing to grant that asphalt of penetration 85 to 100 will produce a firmer road than will asphalt of 100 to 110 penetration. However, if I used a penetration of 85 to 100 in New York State climate, it would be only for the first pour. My seal coat would be but one-half a gallon with a penetration of about 150, for reasons I will explain later.

I do not know how much gravel or sand is available in Rhode Island nor do I know how much it would cost per cubic yard there to put it in place, for a foundation under the whole road. If Rhode Island has anything at all to learn from our practice, it would perhaps be to reduce the bottom course to 4 ins. and put an extra foundation course of cheap local material under the entire bottom course. It would have to be of some cheap granular material otained nearby the road and very likely it is not available. Her 8-in. roads no doubt carry present day loads in a satisfactory manner, but the factor of safety is probably not very large. Extra thickness of pavement, if it can be obtained cheaply, might well be worth while as a safeguard against increased loads.

The three main causes of failure of bituminous macadam pavements, in order of their importance, I believe are:

1st. Foundation weakness.

2nd. Bunching up or corrugating of the surface.

3rd. Wear.

In order to verify my impression that foundation weakness was entitled to first place as a cause of failure, I have recently gone over the records of all the asphaltic macadam penetration roads which were built and accepted by the New York State Highway Department prior to Jan. 1, 1914. The records of all those built subsequent to this date I have disregarded as being too young for my purpose. There were 372 such roads which I examined. They were built from 1908 to 1913 inclusive. Of these only 17 were built 10 ins. or more in total thickness and none of these had to be rebuilt prior to 1923, and only a part of one has been rebuilt since that date. Of these 372 roads, 76 were 8 ins. and 9 ins. in total thickness and only 7 of these had to be rebuilt prior to 1923. Since then the whole of two more roads were rebuilt and about 50% of two others. In other words only 14% of the 8-in. and 9-in. roads are rebuilt and these at an average age of about 13 years. The other 86% are still in use and will last a considerable time longer. Of the whole 372 roads 279 were 7 ins. or less in total thickness; most of these were only 6 ins. thick. Of these, 54 were rebuilt prior to 1923 or about 20% rebuilt at an average age of 7 years. Since 1923 the records that I had available did not allow of a complete analysis but from what data I had it appeared that about 5% of these were being rebuilt each year; probably they would be rebuilt faster than this if more money were available.

In designing a structure of steel, which is an exceedingly reliable material of uniform quality, we use a unit stress of about one-fourth the breaking load or one-half the yield point. The failure of a road may not result in so serious consequences as that of a steel structure and consequently we need not use so large a factor of safety. Nevertheless the fact that 20% of the 6-in. roads failed at an age of seven years shows that a large percentage of them had no factor of safety. No one today thinks of building a 6-in. road of any type on a main thoroughfare. We should not be surprised

then that a considerable percentage of these old 6-in. macadams have had to be rebuilt. Indeed some 30% of them were 14 ft. or less in width and this alone caused a loud call for reconstruction. Yet, with all this, some 200 of them are still in use. Naturally, there must be seasons of the year when they are stressed close to their ultimate strength. Some 87% of the 8 and 9-in. roads are still in use after an average age of about 13 years. They evidently had something approaching nearer to a factor of safety. Of those which were 10 ins. or more in thickness only a part of one road has been rebuilt. These thicker roads were very likely located on poor soil or had to meet some unusual condition; otherwise they would probably have conformed more nearly to the standard thickness in use at that time. The record of these 10-in. roads seems to bear out the statement that 12 ins. of gravel sub-base is sufficient for the soft spots encountered in Rhode Island.

If we take these figures just as we find them, it seems to me that bituminous macadam pavement need not fear comparison with any type of pavement of reasonable cost, at least so far as durability goes. Indeed when we recall the fact that numerous modern concrete roads, and not a few brick roads on concrete foundation, have been rebuilt after a much shorter life than this, we begin to wonder how these thin macadams have stood up as long as they have. I call your attention to the fact that the percentage of failure of the 6 and 7-in. roads was nearly twice as large as that of the 8 and 9-in. roads. To my mind this points unmistakably to the fact that insufficient thickness, which is analogous to foundation weakness, was the chief cause of failure. The native soil under a pavement must of course ultimately carry the wheel loads, so in building a pavement it is a question of distributing the load over an area of soil large enough so that the unit pressure on that soil will not exceed its bearing power. With a rigid pavement, like reinforced concrete, this is done by making the pavement act as a beam or slab; with a flexible pavement like bituminous macadam, it is done by using such a thickness of pavement that as the pressure is transmitted downward from the wheel through the various layers, it spreads out like a cone and the intensity of pressure on any layer of the pavement decreases downward. In a pavement of uniform material it varies nearly inversely as the square of distance of that layer from the top surface. If this be true, or approximately true, it seems to be a waste of money to build a flexible pavement of materials of uniform strength throughout the depth of the pavement, provided a cheaper material is available for the bottom portion.

Without going into too much refinement on this point, I wish to bring out, in a rough way, my line of reasoning. Probably no one as yet has any very definite knowledge of just how the pressure of a wheel load on top of a pavement is distributed onto the soil underneath, nor just what the bearing power of any particular soil may be under the various conditions that the seasons bring forth. The U. S. Bureau of Public Roads has given us some data on it but much remains to be learned. We do know that many 6-in. bituminous pavements on good soil have carried modern traffic for years. Whatever the maximum unit pressure may be under them, we know that if they were 12 ins. thick instead of 6 ins., the pressure per square inch on the soil would be much less, probably somewhere about one-fourth as much; or if they were 18 ins. thick, about one-ninth as much. These ratios of course depend somewhat on the character of the material in each layer and may be considerably in error, but what experimental work has been done indicates that they are true in a general way. Therefore, with a flexible pavement it would seem obvious that the bottom layer of the pavement need have but little better bearing power than the soil itself, but as the surface is approached, the bearing power per square inch of the layers, should increase. If there were available a large number of road building materials whose bearing power was in exact ratio to their cost, and if it were practicable to build a road, layer upon layer, each one say one inch in thickness; then the economical design would be to have each layer of a different material whose bearing power and price varied uniformly from that just a little better than the sub-soil for the bottom layer, to a layer whose bearing power was just a little less than that of the top course, assuming that the wearing course itself will withstand the wheel loads. This would give maximum strength of the pavement as a whole at minimum cost. While this scheme cannot be carried out to anything like this ideal extent, it can nevertheless, where local gravel or sand is available, be rather closely approximated, and that is exactly what I try to do by using a gravel

foundation 12 ins. thick, a 3-in. slag bottom course and a 3-in. hard limestone penetration wearing course.

You may well ask, why go to the expense of putting down 13 ins. of gravel on the entire road when experience teaches that 6 ins. would probably be enough. The answer is that the whole 12 ins. of gravel costs only $4,000 per mile or about the equivalent of 1 in. of concrete. Experience in 1910 seemed to teach that a 6-in. or 8-in. road would carry the traffic, but time proved differently. I don't know what the future has in store for us in the way of loads, probably they will not become lighter. I do know that an additional investment of $2,000 per mile makes the difference between a 12-in. and an 18-in. road which theoretically increases the strength of the road in the ratio of about 4 to 9. If the old roads had been built 12 ins. or more in thickness, nearly all of them would be in use today. Need we make the same mistake again?

You will note that each 6-in. layer of gravel in our pavements costs about 21c per sq. yd. in place; the 3-in. slag bottom course costs about 45c per sq. yd, and the 3-in. top course a little over a dollar per sq. yd. The costs do not exactly vary inversely as the square of the depth of the various courses from the top, nor do I know that the bearing power of each layer does either. Nevertheless both the price and the bearing power approximate this ideal condition as closely as practicable with the materials available.

There are of course other things beside depth of pavement that affect foundation weakness. I take it for granted that no one neglects drainage nowadays.

The second cause of failure is bunching or corrugating of the surface. Rhode Island, using a harder asphalt, has not been much troubled with it. New York State has had a large amount of it and that is why I use but ½-gal. of asphalt for the seal-coat. This corrugating may not always cause a complete failure but it is quite likely to make the pavement so rough that we wish the road would fail. The chief causes of corrugations in the surface are:

(1) Too soft asphalt for the first pour.
(2) Poor penetration from too much rolling, from too small stone, or from any cause.
(3) Too heavy a seal coat, or
(4) Too much oiling after construction.

You will often hear of corrugations being attributed to hand-pouring of asphalt. This may be true to some extent but not nearly so much as is commonly thought.

Those old bituminous pavements are frequently sandwiched in between new concrete pavements and their roughness is especially noticeable because we compare them with those new, rigid type pavements. The roughness is much less noticeable when we compare the macadam with a rigid type of the same age. All pavements get rougher as years go by and it should not be forgotten that the bituminous macadams are generally the oldest in point of service. Nevertheless if they bunch up they will be rough and this danger should not be minimized.

Wear is the third main cause of failure and with proper attention is not nearly so important as the other two. Until recent years wear on a properly built bituminous macadam was almost negligible. Of course, some wear will occur if the stones of the top course are allowed to become too much exposed, particularly if the stone is soft. A bituminous macadam should be oiled occasionally, just enough to keep a thin mat over the stones. There is generally more danger of creating a rough pavement by too much oiling than there is of its wearing out by too little.

In late years, with the coming of snow removal and the constant use of motor vehicles throughout the winter, the item of wear from tire chains is becoming more and more serious. If you have ever followed behind a motor car which was equipped with loose tire chains and was traveling 30 miles per hour on a brick pavement, you have doubtless seen the chains strike fire on the brick like a flint on steel. This shows that there is considerable force to the blows struck by a cross-chain on a pavement. A vehicle traveling 30 miles per hour and wearing a standard set of tire chains, strikes over 9,000 such blows per minute. Naturally when vehicle follows vehicle in the same snow rut there is bound to be considerable wear on the pavement. If then the asphalt is too hard, it will in a cold climate be brittle and will chip off quite rapidly under these blows of the chains. Once this raveling starts, water enters and freezes and the wear is greatly accelerated. This is why I favor for the seal coat a thin mat of softer asphalt than that used in the first pour.

There is said to be "nothing new under the sun"; certainly there is nothing new in this discussion. My consolation is that a thing does not necessarily have to be new to have value. I believe that the idea of obtaining cheaply a good depth of

pavement by the utilization of cheap local materials for the foundation, does have value. It all seems too simple to spend time talking about and yet I believe that enormous sums of money have been and are still being wasted because for one reason or other this point was overlooked or not fully appreciated. Most of us have at some time or other seen materials imported from long distances for use in the entire pavement when along-side or nearby was local material perfectly suitable for foundation. Aside from the improper selection of type of pavement itself, probably more money has been wasted in this way than in any other.

I have intentionally skimmed very lightly over many important points essential for the success of a bituminous macadam pavement. I did it because I wished to concentrate the fire of my big guns on the importance of making a thorough search in the vicinity of your road for some cheap local material for use as a foundation, the building up of a good thickness of pavement, using cheap materials on the bottom and materials of better bearing power in each layer as the top is approached until you have so distributed your wheel loads over the subsoil that there is a good factor of safety between the pressure exerted upon it and its bearing power.

ROAD MAINTENANCE IN NEBRASKA

By Roy L. Cochran, State Engineer, Lincoln, Nebraska.

(Paper read at 1926 meeting of American Association of State Highway Officials.)

Proper maintenance of its State Highway System is probably the most important function of any highway department. Construction of a road project may take a few months or a year, but the maintenance of this project, after construction, is a continuous operation regardless of time or weather conditions. There are two principal reasons for the importance that should be placed upon highway maintenance: First, to protect the original investment. Second, to furnish the traveling public the most in safety, comfort and economy of travel.

Maintenance is a very broad term, particularly when applied to highway work, but generally speaking divides itself into two general classes: First, surface maintenance; second, maintenance of a proper drainage system. In the first case, that of providing and continuing a proper surface for traffic, the traveling public takes a decided interest, while to the highway engineer provision for drainage is equally important.

In connection with surface maintenance for hard surfaced roads, cracks must be filled, blow-outs repaired and resurfacing and patching must be done. Graded earth or graveled roads must be dragged continuously, particular attention being required after rains. In addition to this, where gravel surface is in use, under heavy traffic the dust nuisance makes necessary the use of oil or calcium chloride. Because of vastly varying differences as to soil and traffic, it is not possible to highly standardize work of this nature, as the correct method varies so greatly, even in the same State or in the same county. Because of this, a high degree of initiative is desirable on the part of the patrolmen and the directing personnel. A trained contractor on construction work develops many methods under the stress of meeting competition and coming out with a profit, while in a maintenance organization there is apt to be a lack of incentive in the development and use of methods which give the best results.

In connection with the maintenance of a highway drainage system there is to be included the keeping of shoulders in repair, maintenance of adequate side ditches, protection from scouring, etc. Culverts and bridges must be kept open for drainage, as well as in a proper state of repair. Steel bridges are to be kept tightened up and repainted in order to prevent deterioration. Timber bridges must be refloored from time to time.

In addition to the above problems, there is the traffic problem as well. The function of the maintenance organization at all times should be to minimize hazards of every character and promote safety, this being accomplished either by building safety into the highway, or by the installation of warning signs and keeping guard fence well painted. The first can be brought about by improving alignment, widening and flattening curves, daylighting sharp turns and approaches to railroad grade crossings, where grade separations can not be obtained. In the latter case much improvement in safety conditions is being accomplished by the installation of standardized warning signs worked out by the joint Board and adopted by this Association one year ago. The maintenance organization should also take a census of the traffic from time to time, which data together with a correct

account of maintenance costs, will serve to show the efficiency of different types of surfaces.

As to the best solutions for the problems thus enumerated opinions will no doubt vary greatly. Fundamentally, however, it is thought that all will agree that an organization under the complete control of the Highway Department is not only desirable but essential to complete success as to results obtained along the most economical lines. In Nebraska we are about to close our first year's experience in complete charge of our maintenance work, after many years of divided authority and responsibility between the counties and the state, and it is my opinion that there is no class of public work in which it is as imperative to have centralized authority as in the case of the maintenance of the State Highway System. This organization should be so formed under the control of the maintenance engineer, unhampered by politics, as to selection of personnel, so that in each district and each highway or section of a highway some one person with authority to act is responsible. It is thought, too, that the best way to get proper results and develop initiative and incentive is by creating competition in the work to such an extent that each man will take pride in having the road on which he works as good or better than any other man's section.

In the State where conditions are such or finances so limited that the lower type surfaces—such as gravel—predominate, the maintenance problem becomes a particularly important phase of highway work. It so happens that my experience has been principally with this type. Our 6,000 miles system of highways is divided as follows as to type: Hard surface 175 miles; gravel surface, 2,200 miles; graded earth unsurfaced, 3,600 miles. Our regular patrol organization consists at the present time of 510 men, besides extra gangs, employed more or less temporarily, depending on the necessity. All maintenance work is directly supervised by chief patrolmen, each chief patrolman on an average having about 100 miles under his supervision. These men work under our district engineers, of whom there are eight, these district engineers having charge of both maintenance and construction in their respective territories.

As to eqipment most adapted for maintenance work, opinions again vary greatly. The supplying of war surplus equipment by the U. S. Bureau of Public Roads has had a big influence on the type used by Nebraska. Almost up to the present time heavy trucks and drags having been for the most part used. At the beginning of this year, however, many of our older and more worn trucks were replaced with light tractor one-man patrol units, so that at the present time our regular patrol equipment consists of the following: 91 trucks patroling 1,292 miles, 252 tractors patroling 3,528 miles, 121 teams patroling 1,252 miles. In addition, we use such gang maintenance and extra help as is necessary for working ditches, mowing shoulders and slopes, painting bridges, etc. We attempt to have our roads, particularly those with the gravel surface covered by patrolmen every day, with the exception of Sundays and holidays, and in some cases work is required on those days, especially if moisture conditions are such as to make it necessary. Our paint gangs consist of two men each equipped with pressure outfit mounted on truck with sand blast and paint spray. As I stated previously, this is the first year during which we have had complete control, which makes it impossible to give exact annual costs per mile. Our budget for this year, however, is $2,000,000 for 6,000 miles, or an average of $333 per mile, and we now feel sure of keeping well within this figure. This cost includes depreciation on all equipment and snow fence and total cost of all signs and markers erected during the year.

All of the above are problems for the maintenance organization. In addition to the tasks thus far enumerated we have in the northern half of the United States the snow removal problem. The difficulty in coping with this task is increased by the uncertainty each winter as to its magnitude and the time of its occurrence. The snow problem is distinctly one of maintenance and is handled in two ways: One by at least attempts at prevention, and the other by cure. In the one instance by installation of snow fence; in the other by the use of snow removal equipment. A combination of these two schemes seems advisable, using snow fence for cuts and open spaces where experience has shown that drifts are almost sure to collect and supplementing this with the use of snow plows.

There is a constantly increasing demand on the part of the public that highway service be rendered for 365 days of the year. This demand comes not alone from the users of the highway, but perhaps with more emphasis from the retail merchants in the towns and cities whose businesses show a decided falling off

when highways are blocked. The claim of the local merchant is—that he loses a great deal of business to the mail order houses when it is not possible to get to town. In addition to this, the operation of bus lines with regular schedules and the delivery of mail makes necessary continuous highway service. We have found that the use of wooden slat snow fence is the most effective way in which to combat the snow problem where heavy drifts are apt to occur. During the present year we have purchased almost 1,000,000 lineal feet of this type of protection at an average cost of 10 cents per lineal foot. We plan on keeping all of our principal State highways open during the coming winter, using snow plows attached for the most part to trucks, and in some cases tractors, for snow removal. While our trouble in this regard is not as great as in some of the States farther north, we think that the snow removal problem is an economic one, the solution of which will not alone give better service in traffic and promote business as well, but will, in addition preserve the highway and save a great deal of work in the spring after the frost has gone out.

SHOULD HIGHWAY DEPARTMENTS FURNISH MATERIALS TO CONTRACTORS

By Ralph R. Benedict, State Highway Department, Springfield, Ill.

A State Highway Department having a large construction program of concrete roads or roads with concrete bases, wherein Portland cement is used in extensive quantities, will be financially better off if it furnishes the cement to its contractors. For the past twelve years Illinois has had contracts with the cement companies. These contracts are entered into the early part of January each year. We are fully convinced from our experience over this period of time that this arrangement with the cement companies has been the means of a substantial saving to the State; and cite the following reasons for our belief in the arrangement:

First. There is a substantial saving in price.

(a) The State gets the benefit of the retailers' handling cost which usually amounts to 10 cents per barrel.

(b) The cement is usually purchased at the beginning of the calendar year when the price is the lowest, due to inactivity of construction work.

Second. A supply of cement is insured in case of shortage during the construction season, thereby relieving the contractor of doubt or anxiety as to his ability to carry out his contract on schedule.

Third. The cost of inspection is very much less when the State has a contract with those companies in the best position to furnish cement. This does not mean that the contract should be entered into with only one or two companies, but that the business should be distributed among those companies that are able to meet competitive freight rates.

Fourth. The allocation and delivery of cement to the various contractors is controlled by the State. Thus, the State is in a position to divert cement from other sources than the mill originally supplying the contractor, relieving the contractor of any shortage in the event he is in a position to increase his activities.

Fifth. Contractors are relieved of excess carrying charges on their contracts when the State furnishes the cement.

Sixth. States ownership of cement prevents a tendency to skimp in its use on construction work.

Seventh. The State is one of the best single customers of the cement companies from the standpoint of quantity purchased. Therefore there is a tendency to improve the quality by a more liberal compliance with the specifications than would be true if the mills were furnishing only a few individual contractors, even though the specifications were the same and the inspection was the same.

Discounting all of the other advantages, the saving in price alone would more than justify a State Highway Department in its policy of furnishing cement to contractors.

During the past five or six years Illinois has purchased annually from two million to four million barrels of cement. The dealers' discount on this amount runs into large figures over a term of years.

Supplying Aggregate

What has been said of the advantages gained by State Highway Departments furnishing cement to contractors does not apply to all materials entering into road construction. We in Illinois have never been convinced that furnishing aggregate is a sound business propostion. The production of aggregate is not a specialized business as is the manufacturing of cement, and naturally there are many more producers and distributors in the market. Should highway departments furnish all of the materials entering into a road job it would mean that contractors would supply, practically, only the labor and ma-

chinery. This practice would be another objectionable instance of the State or Government in business, and I am fully convinced that the contractors should be given the right to buy where they wish, taking the profit and any advantage in price they might be able to obtain. Also, furnishing of aggregates by the State would stifle competition between smaller producers who are in a position in numerous instances to supply materials for local jobs or contracts.

Paint for Bridges

In Illinois, in addition to cement the State Highway Department furnishes paint for bridges. As the amount used on bridges at the time of erection is usually a small item in the contractor's estimate, we have found it desirable to purchase the material, in that way regulating the quality and quantity to be supplied. We doubt that there is any great financial saving in furnishing such material as paint aside from the fact that we control the product used in the work.

Conclusion

The diversified interests represented by the State Highway Departments present make it almost impossible to draw definite conclusions as to whether the State should furnish materials to contractors. There are so many physical conditions entering into the conduct of work in different parts of the country, and different conditions even in one State, that to make a hard and fast rule or to adopt any resolutions would lead us nowhere. However, as outlined in the opening paragraph of this paper, where a State has a program of sufficient magnitude to warrant its purchasing a commodity entering into road construction, such as cement, and where it can be shown that a large saving is effected, I am firmly of the opinion that it is sound business for the State to furnish such material to contractors.

TWO THOUSAND YEARS OF ROAD BUILDING

By Thomas H. MacDonald, Chief U. S. Bureau of Public Roads, Washington, D. C.

(Address at 1926 meeting of American Association of State Highway Officials.)

One purpose of this paper is to provide a measure by which to form some adequate idea of the real and relative accomplishments of the highway building industry of this nation, and particularly of the membership of this Association, past and present.

Another, probably less possible, is to place before the public the longtime view of the problems of highway building and financing, lifting these, for the moment at least, above the many little passing objections and obstacles that hamper progress.

And yet, another, to bring to those engaged in this work a greater enthusiasm and determination, and a deeper confidence in going forward with the policies and the program we now consider the best practice.

A large undertaking to attempt within the limits of a few pages, perhaps, and admittedly so, but the highway engineers and officials must in justice to their work lift their eyes from the day's work to its compounded significance, to turn for the moment from the details of office and field to grasp intelligently just what has been going on in these United States when projected against the progress of the world after two thousand and more years of road building.

And so, too, for the whole highway industry, and even more truly for the general public, because of its control over public policies today in sharp contrast with the one-time power of single rulers so absolute that they alone determined the dimensions of public work. Here is the first and one of the most vivid contrasts between the present and the past. There has been too much recitation of fact from history imposed upon us without intelligent interpretation. To cut away these foggy fictions to permit an understanding of the underlying truth will clear from our minds much rubbish and many inhibitions that have combined to lessen the degree of leadership this great public business demands and must have.

There have been just three great programs of highway building within recorded history that by the major tests of area served and mileage completed may be classed together:

That of the Roman Empire, beginning with Julius Caesar and extending to Constantine;

That of France under the Emperor Napoleon;

That of the United States during the past decade.

From the data it has been possible to examine it has not been possible to determine limiting dates with exactness from the Roman and French periods, nor is it necessary. There will not be entire agreement with the period assigned to the United States. It is hoped with more complete research to fix these periods more exactly, but the difference of a few

years either way is not important. To understand the underlying reasons, principles and the results of these earlier great road building epochs is important. To gain from them their wealth of information bearing upon civilization and reasoning by analogy to apply this knowledge wrought out of national experience to the projecting of the long-time curve of probabilities in the United States is most important.

The Roman Road Building Period

The fact is recorded over and over, and public addresses have innumerable times reiterated that the Appian Way, the first of the great Roman roads, was commenced in the year 312 B. C. by the Censor, Appius Claudius, under the Republic, and extended from the Porta Capena, Rome, to Capua, about 125 miles distant. But we are confused by the assertion that the Via Aurelia, the second paved highway, was built about 242 B. C., or 70 years later. With the growth and extension of the dominion of Rome, road building progressed so that we read, "The most ancient remarks we can find in the Roman history of the highways made in Italy to which several magistrates afterwards added so much, that in the days of Julius Caesar, the city of Rome was by them joined to all the regions and principal cities of Italy and through Augustus Caesar and the following emperors made extraordinary works there, it was rather to enlarge and repair them than to make new ones from beginning to end, excepting some made by Domitian, Aurelian and Trajan."

Julius Caesar extended the rule of Rome until there was included in the Western Empire the contries around the Mediterranean Sea, France, Belgium, Netherlands, Great Britain and parts of Germany, Austria and Hungary. At the height of his power, he was made Overseer of the Appian Way and expended large sums from his private purse to repair and extend this great highway. The rulers sent from Rome to administer the provinces carried on the work of road building. But a little later we read of Augustus, "This great and fortunate Emperor finding himself in a settled peace with so many legions (estimated at 173,000 men) on his hands which might be debauched by sloth, thought he could not better employ so many men, dispersed throughout the provinces, than in making of new highways in all parts of his Empire. . . ." In addition there were drafted for this work the common people, the mechanics and artisans, the criminals and condemned persons, so that, "In short, we may conclude it was not one kingdom, or one region alone, that furnished men to work upon such a vast design, but that all Europe, Asia and Africa, set their hands to it. And that the greatest and most potent kingdoms that once flourished in said parts of the world were employed at it whilst they were subject to the Empire; which can not be said of any other work in the universe."

This work was carried forward sometimes in a desultory way and sometimes on a large scale under succeeding Emperors, but it reached its height under Augustus about 300 years after Appius Claudius began the Appian Way and in the decade before the birth of Christ.

The Napoleonic Road Building

A brief word is necessary to bridge the Dark Ages (500 to 1150 A. D.) and the Middle Ages into the eighteenth century. With the decay of the Roman Empire the world road system as such broke down, although quite different conditions prevailed in different countries. Religious pilgrimages, the Crusades, the journeys of the secular rulers and the high dignitaries of the Church leave some record of the use of trans-State and transcontinental routes, but the records of commerce are meager. The general tendency was all toward feudal government which resulted in neglect and the actual tearing up of some of the ancient roads as a method of protection. Also, not only the roads but the magnificently built public and private buildings were wrecked to provide building materials. During this period ancient Rome was ravished to a much greater degree to provide building materials and metals than by conquest, fire or other causes.

Napoleon became first consul of France in 1799 and began at once to build a system of national roads. In 1804 through a plebiscite the people by an overwhelming vote decided he should become Emperor, and that year before the high altar of the Notre Dame Cathedral he placed a golden laurel wreath upon his own head. Also he crowned himself king at Milan of the Monarchy of North Italy. Thus at the beginning of the nineteenth century, a large part of the same area that had been ruled by Rome, twelve and one-half centuries later was again brought under an Empire, this time that of France. The Corps des Ponts and Chaussees had been established in 1796, and was composed of trained engineers through the workings of the earlier established technical schools. So when the Emperor demanded and vig-

orously supported a big program of road building, large accomplishments were possible through the available organization. M. Prony, the Director of the Ponts and Chaussees, described as an engineer of first rank, drove into execution this work. From 1804 to 1813, the expenditure for roads and bridges from the national treasury is placed at 300 million francs. On December 16, 1811, a decree was issued which established a uniform system of highway administration the general principles of which have remained unchanged. This decree divided the roads into imperial and departmental routes, and fixed the financial responsibility upon the Federal Government and the Departments. It designated 14 imperial roads of the first class leading from Paris to the principal cities of the frontier, 13 imperial roads of the second class from Paris to the less important cities on the frontier, and 202 roads of the third class joining interior cities, a total of about 17,000 miles. The departmental roads numbered 1,165, in all about 12,000 miles. These national routes included the Mont-Cenis, completed in 1805 to connect Paris with Turin, and the Simplon, completed in 1807 to connect Paris with Milan Rome, and Naples.

In an incomplete, imperfect way these facts present the only great road building programs that may be compared with that with which the United States is now engaged, but their aspects are very different than we have been led to believe. Both the Roman and the French systems have come down through history as military highways. On the contrary the greatest expenditures were made and the most extensive mileages built after the boundaries of both empires had been extended to their greatest dimensions. Certainly these roads were used for military movements, but both the Emperor Augustus and the Emperor Napoleon threw their energies into road building to make possible the administration of a great empire, to stimlate commerce and to provide food sufficient. Napoleon said, "he feared popular insurrections due to economic causes though he was not afraid of political risings." In other words a transportation system, adequate and complete, is a fundamental requirement of a nation large in its physical dimensions. On this basis we must, in our conception, link our railroads and motor vehicles and highways. Together they supply the most adequate, most efficient transport system any like area in the world possesses or has ever known.

In the Empires, authority from a single source was supreme, in this Democracy we are dependent upon co-operation between the States and the Federal Government to complete an orderly system of highways that will permit traffic and commerce to flow uninterrupted. In a major degree also we must depend upon co-operation, not legislation, to establish co-ordination between railway and highway.

More than 125 years ago France placed her highways under competent technical direction and provided for a system of technical instruction to train men. Generally speaking, the technical equipment of our highway engineers is very good and constantly improving. When fitness for the position and integrity of character are made the first requirements for appointment to highway departments, there will be no more highway administration scandals. Until this is done we can hardly fail to have at least isolated cases of a breakdown of efficient and honest administration.

A Glance at Present Day Conditions

Of chief interest to us in the United States is the effect that past history has had upon present day road conditions since it may help us to see further ahead and certainly the experiences of civilization in the older countries ought to have much of value in formulating broad plans for the future.

Italy, with a relatively small nation in area, of about 120,000 square miles, has a population of 39,659,944. The population has clustered thickly along the world old lines of highways, has crowded in upon the rights of way, and there are many villages. There is a large amount of foot and animal drawn traffic, but the maximum flow of automobile traffic reported near the population centers is 3,300 vehicles in 15 hours. The Italian Premier, Benito Mussolini, in his final address to the Road Congress stated, "Italy has a great road problem to solve; new roads necessary to promote her agricultural life, to facilitate her commerce, and finally, arteries necessary for international tourists in order to render her beauties accessible. She possesses, moreover, a conspicuous road patrimony formed during many centuries by the work of countless generations." Apparently the surfacing and maintenance problems in Italy are of first import, but the new alignments that will be necessary, or perhaps even new rights of way, in many cases present, certainly, "a great road problem to solve." So serious is the problem of alignment

and widths of highways leading from the large population center of Milan that about 50 miles of toll motor roads have been built under Governmental franchise by private corporations.

France and Belgium have a wonderful heritage in the systematic plan that was laid out and begun prior to, and developed and completed since, the Napoleonic Decree of 1811, so that the layout and classification of the highway systems in these contries on a nation-wide basis for uniformity and adequacy of planning are perhaps superior to anything in any like area. The Polytechnic School and the Ecole des Ponts et Chaussees supply the highest ranking engineering graduates for the highway work. In both these countries there is a considerable mileage of main routes paved with stone blocks but the surfacing problem on long mileages of macadam is important. A series of experimental roads have been built near Paris for testing various types of concrete slab and bituminous construction as well as surface treatments.

In Austria and in Czechoslovakia also the surfacing problem on the main roads is of first importance. There are in existence some splendid highways which we are informed date back to the time of Marie Therese. Near Vienna and again near Prague experimental roads are under construction in which both the bituminous mixed types and concrete slabs have been made. These appear to be the first roadways which have been laid in these countries corresponding to the standard types of pavement in general use here. We were informed that following establishment of a school for technical instruction in France, a school was established in Prague, and whether from this school emanated the standards that were set up for the national road construction is not made clear, but in any event some of the best roads, those more nearly corresponding to the best modern standards in alignment, substantial proportions, width and adequacy, are found near Prague. Where such roads existed an adequate modern surface will complete roads of the highest class.

In Germany the road work has been carried on by the individual States rather than through any central direction, so that the highway service now is on a State rather than a national basis. The Federal Director of Traffic states that the major problem is to provide national routes. An experimental track, similar to that used in the Pittsburgh and Arlington tests, has been built by one of the States for testing the relative values of the various types of construction that may be used .

In Great Britain, with an area of 50,000 square miles and a population of 37,000,000 people, the traffic problem has become acute within and between the big cities. The Ministry of Transport has built some arterial roads to relieve bottle necks and to establish through lines of communication. Where these have been completed as parts of established routes they are carrying a very heavy traffic and have afforded wonderful relief. This work, however, was taken up at the particular time to assist in providing employment, and a part, at least, did not accord with the views of the Minsitry of Transport. Where entirely new roads have been opened, width of roadway, alignment and engineering features show splendid vision in providing for the future. But in order to make them fully effective much more work and further expenditures are necessary and this is the difficult problem.

The feature of the work here which deserves the closest attention on the part of the engineers of this country is the new roads which are being laid out to by-pass the congested streets of villages and towns. A typical illustration of the fact that human nature is very much the same the world over, is the record of the fight made by one of the towns established possibly during the time of William the Conqueror to prevent a by-pass being constructed around the town to take the traffic out of the narrow crooked streets of a very densely populated district. The problem of new bridges over the Thames and opening of new traffic ways in London County present problems of first magnitude which the Ministry of Transport is now courageously attacking. It is difficult for us to realize in this country the obstacles imposed by the tremendous weight attached to personal and property rights in Great Britain. To illustrate: Because in the olden days the city of London collected customs at its gates, farmers having supplies to sell formed the habit of stopping just outside the gate and the people came out from the city to buy. So gradually there was established a market. At the Aldgate a hay market was established. As the population settled and as villages grew up all around the city of London, which itself is just one mile square, the hay market still persisted and today one of the main traffic arteries to the docks and warehouses now runs through this old market. On certain days of the week the hay carts are parked

from curb to curb leaving only room for passage of the street cars in the center. It is doubtful if any area in this country presents as complex and difficult problems as the London County area in the immediate vicinity of the city of London, many of which emanate from ancient rights, customs and traditions. The country roads are largely of macadam construction, surface oiled. They fit into the English countryside and offer most delightful recreational opportunities, but they can not supply the facilities necessary to heavy traffic arteries.

In Sweden experimental roads of different types have been built near Stockholm and a very active debate is taking place as to the best types of road construction. But the real problem at present is to realign, widen and grade the old roads to offer proper facilities for motor traffic.

In Amsterdam, as would be expected, the foundation problem is very important, but high technical skill has been exhibited in the construction of roadways. Some of the best asphalt pavements in Europe are in this city.

Denmark is supplied with an arterial road system with ample right of way and a large mileage of stone block pavement. There are also experimental stretches of road near Copenhagen and there is a departure from the usual type of such roads in that parallel lanes of different materials have been built and the traffic is divided between the pneumatic, solid rubber and steel tired vehicles, each taking the lane provided for that particular type. One of the notable types of traffic here is the bicycle. In a population of 3,289,183, we are told there are one and one-quarter millions of bicycles, and apparently most of these are on the road at the same time.

Contrast With the United States

Considering the rural highways there are two outstanding contrasts between the United States and the countries here touched upon, the character and extent of highway traffic and the highway finances. The motor passenger car is regarded still, as in an earlier time in the United States, as a luxury and treated as such, and so it is a luxury. The prices of new cars are high, though there is a very rapidly growing production of lower priced types. Motor fuel is high. Annual taxes are high. Conseqently the development of the use of passenger cars in any of these countries can not be remotely compared with the use in the United States. Driving over the national roads of France for example, once outside the immediate influence of the large city the motor traffic is so small, in fact all traffic is so limited that it is evident there is a very different kind of life prevailing in the rural communities than that which exists here. While there is much very short radius motor traffic in the large cities, the people generally have not discovered the potentialities of motor transportation either for business or recreation. They have not yet found the way to know their own countryside, their country's scenic attractions or the commercial advantages of fast, convenient transportation. From a limited viewpoint, conditions appear very much as they did in this country 10 or 15 years ago, just before the avalanche of motor vehicles enveloped us. A similar turning to the use of motor vehicles will come but probably it will be somewhat reversed. Our private motors came first and public later. Possibly in Europe the public motor vehicle may develop first in a large way, both buses and commercial haulers, to be followed by a large use of the private motor.

Financial Aspects

Everywhere the highway officials are laboring under the severe handicap of lack of funds. When it is remembered how many of the European countries finance the entire cost of the national highways, it is easily understood, with the national treasuries and currencies in their present conditions, what great difficulties stand in the way of renewing and rebuilding their highways to modern standards. It is undoubtedly this situation that has turned Italy toward a favorable consideration of the motor toll road, privately owned.

In view of the demonstrated capacity of improved highways to stimulate commerce and to make possible new lines of profitable production, it came as a shock when we were informed that a bond issue for much needed rehabilitation of important highways in one country had been forbidden because such expenditures are not capable of producing a direct return—proof unanswerable that in high places modern highway transport is believed a luxury and not a commercial necessity.

Simple but important conclusions shape themselves with the present day highway conditions of Europe projected against the background of the highway history of the two thousand years since the beginning of the Appian Way, a section of which may be seen today crossing the Campagna, toward the Alban hills, preserved as an interesting and valuable historical record; but the traffic is carried over another highway and itself has about the same relationship to modern road

building as the skeleton outlines of the cliff dwellings in our West have to modern architecture. The likeness to the original is about the same in each.

Highways are a thing of service. Service requires changes; they must themselves change; and to provide adequate service over the largest possible mileage and at the least cost is the requirement just now, and there is abundant evidence that this has always been the policy when efficient highway service was required over a large area.

This building up under service, only another name for stage construction, has always prevailed. Our roads must be maintained and strengthened, certainly and constantly, but this has always been the case. Referring again to the Appian Way, we have the record of its being repaired and rebuilt for at least 500 years although the first section was, we read, so expensively built as to wreck the Roman treasury. History asserts loudly the fact that once he has set traffic going over a highway, the work of the engineer has just begun.

As to standards of construction, there again is fixed only the one unfailing measure, that of adequate, satisfactory service at minimum annual cost. No more, no less, is necessary.

On the other hand, what tremendous support history supplies for correct principles of administration. France and other countries which for a long time, from 100 to 150 years, have had an adequately planned national system with the roads classified in accord with their importance and with a highly qualified technical corps to carry into execution the administrative principles, have today a heritage of untold value. Their national roads have right of way widths, alignment, gradients, compacted road beds and fine bridges. They lack in many sections top surfacing suitable for heavy motor traffic which will be supplied as it becomes possible. This great heritage for future generations is not a product of extraordinary expenditures but rather the accumulated result of years of consistently following out right principles of administration.

France is not large—about 200,000 square miles—as compared to the United States—about 3,000,000 square miles, and in this great national area we are attempting to secure through co-operation between the States and the Federal Government under the Federal Highway legislation, national routes of high standards. The progress has been such that the eyes of the road builders of the older countries are now turned this way and the methods and results here will exert a profound influence in other nations. This is voiced in no vain or boasting spirit. Rather it is only to build any further protection possible that will guard against any breakdown of the spirit of co-operation between the States and the Federal Government.

This would bring disaster to the completion of a national system of highways. No one can study the rise and fall of highway progress through the years or observe the existing evidence without being forced to this conclusion.

ENGINEERING COMPENSATION

(From a recent number of the "Professional Engineer," official journal of the American Association of Engineers.)

The one great economic problem confronting the welfare of the engineering profession today, and the one in which 99 per cent of the engineers are themselves vitally concerned is adequate compensation for engineers. Compensation is the basic motive back of all activity, whether that activity be industrial, commercial, professional or otherwise. Adequate compensation in its broadest sense means reward or remuneration commensurable with the duties performed and responsibilities assumed. No one can question but that the duties performed by the engineer of today enriches humanity most. No one can say that there is any group of men on whose responsibility the life, health, happiness and comfort of the masses depends more than on the engineer. Yet with such duties and responsibilities the present day economic status of the average engineer places him at the bottom of the list of the professions from the standpoint of earnings.

The engineer of today is the man who stands between capital and labor. He utilizes the money of the capitalist and the skill and brawn of the laborer to create the needs of modern civilization. For this he expects adequate compensation. But what has be been getting? Scarcely sufficient salary to supply the needs of his immediate family. The luxuries and many of the pleasures of this day and age are denied him on account of his low salary. He finds on almost every job, tradesmen and mechan-

81803

ics who draw higher wages than he does salary. He sees what other organizations have accomplished through unity of purpose and co-operation of effort. He also knows that outside of A. A. E. his profession has done nothing to alleviate this condition. In short, the engineer of today is thinking.

Already the tentacles of unionism are reaching out into the ranks of the profession. Already paid professional organizers are promising engineers that relief through unionism which their own profession is not giving them. Already engineers have seen what the engineers of the city of Chicago and of several of the other larger cities have accomplished through the adoption of the methods of unionism, and again I say that the engineer of today is thinking.

Municipalities, industry and employers of engineers in failing to pay adequate compensation to engineers in their employ are today doing more to drive engineers into unionism than all other things combined. If such should happen then the engineer, who today stands as the arbiter between capital and labor, will tomorrow side with labor against capital.

No learned profession can justify its ethics by embracing unionism or employ the weapons of unionism to further its demands. However, the handwriting is on the wall and if we wish to save our profession from the taint of unionism it is up to us to act.

The American Association of Engineers keenly senses this undercurrent of unrest abroad in the profession. The Association also stands squarely opposed to unionism within the profession. It realizes that the time has come when an honorable and organized effort must be made by engineers through their technical and professional organizations to alleviate the present economic status of salaries for engineers. Such an effort, however, must be predicated on a basis that will educate the public to the value of the engineer to community life and not upon any plan that savors of threat or compulsion. It must be predicated on a basis that will educate the public to the fact that engineering is a position of trust and that as such it must ever be kept free from taint of bias, partiality or favoritism. It must be predicated on a basis that will convince employers of engineers that it is to their interest to pay adequate salaries to engineers in order to keep them in the position of the man who brings together the interests of capital and labor. It must be predicated on a basis that will enlighten the public to the fact that engineers are today at the bottom of the list of the professions from a standpoint of average earnings. It must be predicated on a basis that the engineers' services to civilization and human progress are invaluable, and, last but not least, it must be predicated on a basis that will enlighten the public of the economic plight of the men who have spent years of time and study in order that they may serve humanity's needs.

The American Association of Engineers stands today definitely committed to a policy of adequate compensation for engineers. It stands ready to give its time and energy to the accomplishment of that end. It stands ready to plead the engineer's cause before his employer and before the public. It is giving its time and energy toward the accomplishment of that end, and it is today actively engaged in the task of bringing to the public's attention the dependency of modern civilization upon the engineer and the niggardly reward for his services.

LARGEST INSTALLATION OF HIGHWAY LIGHTING

The placing of 250 General Electric Novalux Highway Lighting Units on the 15 miles of road leading from South Jacksonville, Fla., to Pablo Beach completes the largest installation of highway lighting in the country. The lights are spaced 300 ft. apart on a pole line set for the purpose and are on one side of the highway only. They operate 250-candlepower lamps and are 30 ft. above the surface of the highway. The equipment also includes a 50 kw. Type RV transformer.

As this is the main thoroughfare leading from South Jacksonville to the beach the traffic during the summer is very heavy. Until recently the brick highway was too narrow for the amount of traffic it carried, and there was no lighting equipment. It is now a double concrete highway, and since the lighting units have been installed there has been a noticeable decrease in the number of accidents which have occurred there.

CITY TRAFFIC PROBLEMS

By A. R. Ross, Mayor, Lafayette, Ind.

(A paper presented at the Thirteenth Annual Road School held at Purdue University on January 17th to 21st, 1927.)

The automobile traffic problem is one that is confronting practically every city and county seat of any material size. This problem has rapidly developed in recent years and with an average annual increase of from ten to twelve per cent in the number of automobiles, the problem will become more acute for each municipality. Most of our Indiana cities have comparatively narrow streets, with but little, if any, opportunity to widen them. The object in traffic control is the conservation of life and limbs and the orderly movement of the traffic. In the points to be submitted in this paper the conditions in Lafayette will be dealt with, in the belief that with slight modification the conditions are present in every Indiana city of any size.

The width of the downtown streets in Lafayette from curb to curb varies from 30 to 51 ft. The maximum width is found on the four sides of the public square, but the greater majority of the streets will not average over 36 to 38 ft. in width. Automobiles parked parallel to the curb will extend 6 ft. into the street, and where angle parking is established the machine will extend from 10 to 13 ft. into the street. Our principal street has an average width from curb to curb of about 39 ft., and with double street car traffic traversing its center, and a solid row of automobiles parked parallel to the curb on both sides of the street, it can be readily seen that there would not be sufficient room between the street car and the parked automobile for the passage of any traffic. This condition results in numerous traffic blockades due to the stopping of street cars to take on and let off passengers. This condition also constitutes a constant menace of obstructing the Fire Department in making its runs where it would be most necessary for it to arrive promptly, in the congested portion of the city.

In order to secure more definite data, upon which to base corrective measures, and with the co-operation of the Engineering Department of Purdue University, under the active direction of Prof. G. E. Lommel, a twelve hour traffic and parking census was taken on Saturday, March 6, 1926. This was a rainy day and would not show a maximum number of cars that would be on the congested streets, but some very interesting conditions were disclosed.

The point of heaviest traffic conditions was shown to be at the corner of Ninth and Main Streets, which is a transfer point for street cars leaving in four directions. Without counting the north and south bound motor traffic, or the west bound traffic turning into Ninth, it was shown during the twelve hours, 4,594 vehicles and street cars passed through this busy center. The result of this showing was to place a traffic officer at that street intersection.

Of the total traffic, 32,747, moving in and out of the business district, 5,602 or 17.1 per cent was truck traffic; 566 or 1.7 per cent was horse-drawn, and the remainder, about 81 per cent, was motor-driven, both business and pleasure.

Another condition prevailing in Lafayette consists of the two bridges crossing the Wabash River and these furnish the only means of crossing the river within a radius of seven or eight miles in either direction. The Main Street bridge was shown to be the busiest place disclosed in the census, as 7,922 vehicles passed during the twelve hour count, reaching a maximum of 742 for the half hour period from 4:00 to 4:30 p. m. As disclosing the relative importance of the two bridges across the river it was shown that the total traffic over both bridges was 8,359 vehicles, and of this number 94.8 per cent passed over the Main Street bridge while the Brown Street bridge carried but 5.2 per cent. This showing clearly indicates the desirability of so routing traffic as to relieve the Main Street bridge and throw some of the traffic to the Brown Street bridge to the north. In order to help toward the solution of this problem and to relieve the downtown portion of Main Street of its heavy traffic congestion, an ordinance was enacted creating four through streets running east and west parallel to Main, two to the north and two to the south of that street. The result of the operation of this ordinance has been very gratifying in relieving Main Street of considerable traffic and this result was further assured by removing the traffic signafores on the through parallel streets and leaving them installed on Main Street to encourage the motorist to take one of the side streets where he would not be delayed by the red signal of the signafores.

In order to prevent additional congestion of our Main Street, resulting from the construction of State Highways, the city administration in co-operation with the State Highway Commission are routing as much of the through traffic down the side streets and across the but little used Brown Street bridge as possible. In this connection it might be said that it is to the very material advantage of cities to co-operate with the State Highway Commission in by-passing tourists from their congested business centers, and not be misled by any sentiment of local merchants in their mistaken desire to have traffic routed through the center of the town. Most tourists wish to go through the city and appreciate the opportunity of doing so without being delayed by passing through the congested district, and those tourists who wish to stop will do so regardless of how the through traffic is routed.

Another very definite traffic obstacle with which we have to contend in Lafayette is the passing of long freight trains over the Monon and Wabash Railroads through the business section of the city. This obstacle is most marked in connection with the Monon Railroad, as it passes directly through the center of the city from north to south on Fifth Street, and during the twelve hour census approximately 8,000 automobiles crossed this railroad. During this period moving or stationary trains occupied the crossing for a total of about 29 minutes, which would mean that roughly 350 automobiles were held up for approximately 30 minutes. This certainly indicates a definite economic loss of considerable importance.

Closely allied with the traffic problem in the way of traffic obstacles are the automobiles that are permitted to be parked on our downtown streets. A very material addition to this type of obstacle results from the local business or professional men who park their cars all day and thus maintain a constant traffic obstacle and prevent the out-of-town customers of the business men the convenience of ready access for shopping purposes.

In the parking census that was taken, as a part of the study, a total of 10,457 parked cars were counted. Because of a rather heavy rain in the afternoon this census was not as completely successful as was hoped for it. However the result disclosed the selfish use of the streets for parking purposes by a number of citizens, namely:

60 cars were parked 9 hours or more.
83 cars were parked 8 hours or more.
98 cars were parked 7 hours or more.
120 cars were parked 6 hours or more.
143 cars were parked 5 hours or more.
180 cars were parked 4 hours or more.
282 cars were parked 3 hours or more.
382 cars were parked 2 hours or more.
558 cars were parked 1 hour.

In round numbers 1,700 cars could be parked in the territory covered by the parking census and at 2:00 p. m. on March 6th almost 1,400 cars were parked in this district, of which 62 were double parked in 14 different blocks. It is estimated that these parked cars cut down the street efficiency for traffic between 25 and 35 per cent. During the day 88 cases of double parking were reported on 28 different blocks.

Some of the conclusions submitted as the result of this traffic and parking census were that either a no-parking or limited-time parking regulation be established on Main Street.

That some provision should be made to care for the obstruction caused by trucks backed up to the walk for loading and unloading.

That the number of taxicabs that could be parked in front of the taxi offices should be strictly limited.

That parking space, for long time parking, should be provided either by the city or the merchants.

That as much as possible of the traffic be diverted from the congested Main Street bridge to the less used Brown Street bridge in crossing the river.

In attempting a solution of the acute traffic and parking situation confronting Lafayette, an ordinance was first enacted, as already noted, establishing four through streets parallel to Main Street and encouraging traffic to use these streets. The next measure taken up for consideration was that of a limited time parking ordinance to cover the more congested business districts with one and two hour parking limits, according to the importance of the street. Early in the consideration of this problem we were confronted with the advisability of providing a free parking space for long time parking in order that the enactment and enforcement of a limited time parking ordinance would not result in residents of the country districts going to the small villages and staying away from the county seat because of no avail-

able place for parking their cars while in the city. Since it would be very difficult, if not impossible, to prevent residents of the city from using most, if not all, of the parking spaces available on streets outside the limited time parking district; there would be little, if any, long time parking space available for the people from the country, unless they would go to a considerable distance from the business section of the city. As a solution of this problem an option was secured on property located between the two bridges crossing the river, and easily accessible from both, to be used as a Municipal Parking Ground. The plan involved in connection with the parking ground—a small building equipped with toilet facilities for both men and women, a free checking room for the patrons to check their parcels, the whole parking space to be encircled by a fence and in charge of a custodian to render needed service to visitors to the city and guard against theft of automobiles. The City Council authorized a bond issue of $52,000 to cover the purchase and equipment of this parking ground.

We immediately encountered opposition, almost wholly of a political character, which resulted in an appeal being taken to the State Board of Tax Commissioners by a group of local remonstrators. A public hearing was held by one of the State Tax Commissioners and not one shred of evidence was submitted by the remonstrators to sustain the points included in their remonstrance and the large audience of local business men who were in attendance signified they were very much in favor of the proposed bond issue. The Attorney for the remonstrators raised the legal question that a City Council did not have the power to authorize a bond issue for such a purpose, but the State Tax Commissioner stated that that was a question for the courts to decide, and on the merits of the proposed bond issue for meeting a very great public need the State Board of Tax Commissioners subsequently approved the bond issue.

The law under which the city administration proceeded in its effort to secure this much needed assistance in solving the parking problems was "An Act Concerning Municipal Corporations—Approved March 6th, 1905, under Section 92," in which the following power is granted to the Board of Public Works: "To condemn, rent or purchase any real estate or personal property needed by any such city for any public use." It would be difficult to conceive of anything that could be more clearly established as constituting a public use than this plan of providing a parking ground for a large number of automobiles in order to make it convenient for out-of-town shoppers and long time visitors to park their cars, and to facilitate the enforcement of a limited time parking ordinance, to better meet the needs of the customers of our local business men, and to clear our local streets from the constant menace encountered by our Fire Department in making its runs to fires.

When the bond issue was advertised for sale, the different bond houses submitted their bids subject to the approval of their attorneys. The attorneys of the bond company who were the successful bidders, advised the bond houses against purchasing the honds, because of the fact that Lafayette was the first city in Indiana to issue bonds for the purpose of a Municipal Parking Ground and that there was no court decision establishing the fact that this constituted a public use within the meaning of the law. These attorneys were influenced in their decision by information conveyed to them by local opposition to the project, that a Lafayette attorney had been retained to take the matter into the courts and thus involve the bond issue in litigation. These attorneys did not question the very great need of Lafayette for such a parking place to relieve the congested business streets and they did not question that such a project constituted a public use within the meaning of the law. But in the absence of a court decision definitely establishing that fact, they would not recommend the purchase to the bond company because the small commission it would receive would not justify it in placing a bond issue in the hands of any customer that was to be involved in litigation. This matter is still pending but it is of such a character that it should be of interest to the officials of every city in Indiana.

A number of cities in the State are almost certain to be confronted with the necessity of doing something to relieve their congested business streets and retain the out-of-town customers of their local merchants, as that kind of business constitutes an important factor. For any city to purchase ground to provide a free municipal parking space for a large number of automobiles for long time parking, and to facilitate the en-

forcement of limited time parking regulations would seem to be a very clear and very definite public use. By no argument could it be proven that such a project was not for the purpose of giving a definite public service. But in the absence of a court decision establishing the fact that such a project constituted a public use, any city in the State would probably encounter the same difficulty that Lafayette did in negotiating with financial institutions for the purchase of bonds authorized for such a purpose.

In the enactment of no parking and limited time parking regulations in our cities, there are a number of factors to be taken into consideration which will apply to most of our cities with but slight modifications to meet local conditions. No parking zones must be established where needed to meet the needs of traffic. The operation of street cars, taxicabs and large motor buses with the location of their terminals are factors to be taken up and definitely provided for in any regulatory measure. The establishment of through streets and the bypassing of through tourist traffic are also items to be considered in the solution of the general problems of relieving the narrow congested streets in the business portion of the city from its heavy burden of traffic.

In conclusion it is hoped that some of the points submitted in this paper may be of service in the way of suggestions to the officials of other cities. The paper has dealt rather specifically with conditions existing in Lafayette and the definite measures undertaken to solve our local problems. We are fortunately situated adjacent to Purdue University and were enabled through the co-operation of its representatives to conduct a valuable traffic and parking census which gave us definite information on which to base remedial measures. In other cities not so fortunate as to have the expert service available from Purdue University, it should not be very difficult to have a traffic and parking census taken through the co-operation of the Boy Scouts or some similar organization. The Boy Scouts of Lafayette actively assisted in the traffic and parking census we held. If each city will learn by such a census its own traffic and parking needs the officials can then plan along definite lines to meet the local problems presented. These problems for all of our cities will become more acute as the number of cars increase and any plans adopted for their solution in any city should provide for the future demands of traffic insofar as it is possible to do so.

THE PARKS AND PARKWAYS OF WESTCHESTER COUNTY, NEW YORK

By Jay Downer, Chief Engineer, Westchester County Park Commission.

(Paper read before the Fifth Annual Asphalt Paving Conference, Washington, D. C., November 8-12, 1926.)

Westchester County includes 447 square miles of territory lying between the Hudson River and Long Island Sound and forming the only mainland approach to New York City. Within the county there are the four cities of Yonkers, Mount Vernon. New Rochelle and White Plains, 18 villages and 23 townships. Westchester has a population of about 500,000 people and property aggregating more than one billion dollars assessed valuation. Its population, wealth and yearly budget exceed those of many of our western states.

Such is the territorial and economic background of the great county park system now in process of rapid development and including water-front parks along the Hudson River and Long Island Sound, interior parks, reservations and connecting parkways. This system embraces 15,289 acres of park and parkway lands, 9 miles of shore and beaches and 140 miles of parkways. The rapidity of progress in establishing this great system during the past three years constitute a record probably unmatched by any other municipality.

For a better comprehension of the park system it should be regarded as embracing some of the principal elements of a great skeleton plan for the county's future development and growth.

This growth has, in recent years, proceeded at a rapid rate largely due to electrification of railroad lines providing fast service for commuters to New York City, and to the development of automotive transportation. From the earliest beginnings at the Battery the growth of New York City naturally moved northward on Manhattan Island. This growth crossed the Harlem River long ago and in recent years has passed on up to Westchester County in what should be termed a surge rather than a spread. Once a rural area of farms, country estates and scattered villages, the south-

erly portion of Westchester adjoining New York City is becoming solidly built up. It became apparent to leading citizens and county officials that unless park areas were acquired while some vacant land remained, the opportunity would soon be forever lost.

Reference has been made to the territorial and economic background. There is a third fundamental vital to our practical accomplishment in meeting the need for the park system namely, an efficient, capable county government endowed with the vision and courage to proceed with a program on an unprecedented scale. The undertaking is, moreover, backed by a strongly supporting public sentiment founded on confidence in the ability of the government to carry it through.

In 1807 when commissioners were appointed to prepare a street plan for New York City, they laid out the north and south avenues and cross streets up to the Harlem River. But to save themselves from ridicule, explained in their report that they did not expect the Harlem plain, then consisting of farms, woodland and swamps, to be populated for centuries. In less than one century this plain became a solidly built up city of apartment houses, business blocks and paved streets. It requires little vision to see that it will not be a matter of centuries but of a few decades when the Westchester County area south of Tarrytown, White Plains and Port Chester will be closely built up as a suburban or satelite city of the metropolis. But we have already made sure that 8 per cent of this area will be reserved in open spaces for park and parkway uses.

The reserved areas embrace such features as beaches, natural park reservations, forest preserves, golf links and other recreational areas. These separated park areas are tied together by interconnected parkways and boulevards for the circulation of traffic, the whole forming comprehensive system of primary importance in shaping the trend and character of development in Westchester County.

So much for generalizations and some of the underlying fundamentals. In passing to more detailed description, we should first take up the Bronx River Parkway, the first completed project. This parkway was developed as a joint undertaking between New York City and Westchester County and has a length of about 15½ miles, from the Bronx Botanical Gardens in New York City to Kensico Dam in Westchester County, and was undertaken principally for the sanitary improvement of the Bronx River Valley. The Bronx River, like many other small streams in the path of encroaching city growth, had become badly polluted with sewage and by refuse dumps and nuisance conditions along its banks.

The Bronx River Parkway which now forms a magnificent approach to New York City, eliminated the old nuisance conditions and restored the natural beauties of the Bronx River valley. The reservation consists of controlling strips of land on both sides of the stream. Swamps have been drained, plant and tree growth restored and a 40-foot paved motor driveway along the valley now opens its beauties to many thousands of motorists as well as providing the commodious traffic boulevard out of New York City through Westchester County which forms the city's only mainland approach. This driveway has a 7-in. concrete base laid on well drained and compacted subgrade. The 2½-in. bituminous wearing surface in some sections consists of Hastings blocks and in other sections is a continuous sheet of bituminous concrete laid according to modified Topeka or Warrenite specifications.

One of the most advanced features in the construction of this parkway is the elimination of the grade crossings at practically all of the important intersecting thoroughfares. The Bronx River valley follows an approximately north and south course, very nearly paralleling the direction of the main north and south avenues on Manhattan Island. In the Borough of The Bronx and farther north in Westchester County, the Bronx valley is intersected at intervals by east and west thoroughfares as yet in their infancy as to the volume of traffic they will ultimately carry. As the Bronx River Parkway drive generally follows the low ground along the river, the configuration of the ground was readily adaptable for carrying the intersecting thoroughfares on bridges over the parkway drive.

The elimination of these grade crossings probably doubles the traffic carrying capacity of this driveway. A good example for visualizing the situation is to imagine the increased facility that would result in the moving of traffic along Fifth Avenue if the grade crossings at 42nd Street and at other main

cross thoroughfares could be eliminated. Four lines of traffic are easily accommodated on the Bronx River Parkway and a speed of 35 miles an hour is allowed.

The success of this improvement created a demand for more parkways and authority for establishment of the Westchester County Park System was created under a special act of the Legislature in 1922. The first unit or project in the new system was Mohansic Park, including Mohansic Lake and 1,100 acres of land in the northern Westchester hill country about 50 miles from New York City. The principal feature of this park is an 18-hole public golf course developed by the Westchester County Park Commission and used by about 500 players on Saturdays and Sundays. This reservation is also used for field sports and automobile picknicking parties. Over-night camping is prohibited because the outlet from Mohansic Lake flows into the Croton water supply of New York City.

Following the creation of the Westchester County Park Commission in 1922, about one year was devoted to study of the county's needs and the Commission submitted its first report to the County Board of Supervisors for the acquisition of additional lands in 1923. Since that time rapid progress has been made on the greatly expanded program which now includes projects embracing the total of 15,289 acres. Westchester County owns roughly a funnel shaped approach lying between the Hudson River and Long Island Sound and tapering toward New York City.

Early attention was given to waterfront parks and beaches. Along the Hudson River the system includes Kingsland Point Park, where a bath house embodying the most advanced designing and construction has been opened to the public.

Croton Point Park includes 350 acres of land with a large beach and 4 miles of shore line. This peninsula has magnificent possibilities for the development of all forms of recreational facilities on a large scale.

Crugers Park is a tract of 240 acres lying between the Hudson River and Albany Post Road. At this park a large Boy Scouts' camp is operated and individual camp sites are rented.

On the Long Island Sound shore, Glen Island at the City of New Rochelle has been acquired as one of the county parks. This tract of wooded island of the Sound was widely known for many years when it was operated as a family resort by J. H. Starin. A new beach and breakwaters are under construction by the Park Commission and a bridge connecting the Island with the mainland is projected.

Interior parks include Tibbetts Brook Park, an area of aoout 400 acres in the Tibbetts Brook valley immediately north of Van Cortland Park in New York City. Tibbetts Brook Park is located near a populous section of the City of Yonkers and its development with a splendid athletic field, boating lake, concrete swimming pool and bath house is nearly completed.

A few miles north of Yonkers Woodlands Park located in the most picturesque section of the Saw Mill River valley including a small lake, is a popular recreational area.

Silver Lake Park of about 500 acres is near the City of White Plains and Saxon Woods Park near Mamaroneck includes 820 acres near a rapidly growing section of the county.

In the northerly part of the county, the Poundridge Reservation of 3,800 acres and 1,500 acre Blue Mountain Reservation near Peekskill are wild forest preserve areas comparable with the Catskill and Adirondack state preserves.

Westchester County is traversed by a series of north and south ridges dividing the valleys of the Hudson River, Saw Mill River, Bronx River and Hutchinson River. The Bronx River Parkway, as previously stated, has been completed and construction is in progress on parkways following the Saw Mill River valley and Hutchinson River valley. These parkways serve the multiple purpose of protecting the small stream valleys against the nuisance conditions and at the same time provide open recreational spaces, motor traffic routes and the routes for trunk sewers.

In addition to the parkways named, the system includes the Mamaroneck River Parkway, Cross County Parkway from Yonkers to Rye Beach and the extension of the Bronx River Parkway from its present terminus of Kensico Dam to the Bear Mountain Bridge spanning the Hudson River north of Peekskill.

The full development of this great park and parkway program will extend well into the future, but Westchester County has acquired a large proportion of the lands required and the development will proceed in accordance with

public demands for improvements. This park system will be of incalculable value to the people. It has an idealistic aspect but at the same time is regarded by the authorities as resting on a sound business basis. Parks and parkways greatly enhance the value of real estate immediately adjoining the parks and also in a considerable surrounding zone.

Westchester County authorities are convinced that the creation of real estate values on this basis and the great economic value of adequate traffic facilities will in time fully pay for the investment of public funds required for the parks.

The Westchester County Park System is under the administration of the Westchester County Park Commission of nine members serving without compensation and consisting of V. Everit Macy, President; Arthur W. Lawrence, Vice-President; Charles M. Miller, Treasurer; John G. Agar, Cornelius A. Pugsley, Mrs. William A. Read, Mrs. Roberts Walker, William J. Wallin and Felix M. Warburg.

EFFICIENT ROAD MAINTENANCE

By N. M. Isabella, Maintenance Engineer, Wisconsin Highway Commission, Madison, Wis.

(A paper presented at the Thirteenth Annual Road School, held at Purdue University on January 17 to 21, 1927.)

The big problem of today on our highways is one of transportation. While there are many construction difficulties before us, the biggest problem to solve is one that will provide highway service to meet the growing demands of the motor vehicle. There is practically no product on the market but what is effected in some way by transportation. The cost of everything we eat and wear is governed somewhat by what it costs to move that product from manufacturer or producer to the consumer. One of the big factors that tends to reduce transportation cost is efficient highway maintenance. This can easily be seen when one compares some of the experiences he has had on a well maintained road and on an uncared for highway. There is no question but what the cost of operating motor vehicles over a poorly maintained road is much greater than the cost of operating the same vehicle over a highway that is well maintained.

The demand for through highway service that exists today has been brought about by the low priced automobile which is now within the reach of practically every American family. Prior to the advent of the automobile, the great bulk of freight and passenger traffic was handled by the railroads. Today, it is quite different, with the automobile traffic increasing to such an extent that the demand for highway service is growing faster than it can be supplied. Traffic is increasing in quantity, speed, and weight.

This increase in motor transportation has forced the states to adopt systems of highways and to concentrate their efforts on the through arteries of traffic. It has likewise influenced the counties to adopt county systems to supplement the state highways. The influence is gradually extending down to the town and local roads, and when the time comes when the local farmer can travel to market over town, county, and state roads with the same degree of comfort and safety, the problem of highway transportation will be solved. From the experience had thus far, we believe it can be said that a state highway system should be a system of highways interconnecting every county seat in the state; also every city and village having a population of one thousand or more. It should offer full access to the agricultural, industrial, scenic and resort interests located within the state, and should connect with the principal highways in all surrounding states.

In the selection of the state highway system in Wisconsin, a very careful preliminary study was made of the whole state and its possible future development. The main routes were chosen from the best information available. This was followed by a careful reconnaissance survey in the field. Prior to final selection, hearings were held at all county seats where all interested had an opportunity to discuss and present their views as to the proper location in their community. In a great many cases changes were made as the outcome of the hearings and it is evident that by adopting this policy a system of highways was finally selected that fills the general traffic demands of the state. It was determined that the entire state system, whether improved or not, must be maintained from the very beginning. Undoubtedly this last named factor was the most important one in the development and improvement of highway transportation in Wis-

consin. It is held that the establishment of a preferred system of highways by any unit of government should carry with it the immediate maintenance of that system by the establishing unit. It cannot be over-emphasized that a state system of roads should not be laid out unless real state control of its maintenance is also provided.

Various Factors Involved

The maintenance of a highway is much different than the construction. In the building of a highway, definite factors are considered, such as alignment, grade, drainage structures, thickness and width of surfacing, and other details that vary with the locality. In maintenance the remedy or method applicable to one road does not necessarily apply to another. The problem is to keep the road up to its original condition insofar as funds will permit. The condition of the road varies with the type and character of the traffic, drainage, topography, weather conditions, and thus one cannot definitely say what the maintenance cost of a given road will be because these items cannot always be determined in advance. Efficient road maintenance will, therefore, depend on the following factors:

(1) Sufficient funds available.
(2) Organization and equipment.
(3) Proper planning and budgeting of funds to meet traffic demands.
(4) Efficient execution of the work as planned.

Funds Available

Taking item 1, namely, Funds Available, it must be said that to carry out the maintenance work successfully, sufficient funds must be provided. In most of the states, the funds used for maintenance work are derived from revenues collected from motor vehicle fees. The motor vehicle owner is becoming more critical each year in his requirements for highway service, and takes the opportunity of informing the highway official that he is paying the bill and desires that he be given just returns for the taxes paid by him.

Organization and Equipment

In addition to having sufficient funds to work with, it is very essential that the work be handled by a competent organization supplied with up-to-date equipment to do the required work properly.

Proper Planning to Meet Traffic Demands

The future demands of highway traffic must be anticipated from the best available information. Preparations for the year's work should be made well in advance. Probably one of the most undesirable features from the standpoint of the motorist is the closing of the main highway to traffic and requiring him to travel over a detour. If these are not planned for in advance, there is bound to be dissatisfaction from the motorists's viewpoint. The widening of roads for safety and surface treatments to eliminate the dust nuisance on gravel roads are important factors to consider.

Efficient Execution of the Work

After having sufficient funds available, the organization and equipment, and definite plans made to take care of traffic, the last item, and one of the most important, is the efficient execution of the work. This item is important because it involves the thought and energy of the men who actually carry out the work as well as the official in charge.

In the maintenance of our highways in Wisconsin, we have tried to keep these items in mind and in planning our work the thing uppermost in the minds of the highway officials has been to render highway service at a minimum cost and to provide for the public a safe and comfortable highway. One thing upon which all opinions seem to be agreed is that the expenditure of large sums of money for construction is an extravagant use of funds unless followed by systematic maintenance. It, therefore, follows that in the design of a highway the maintenance factors should be considered. The cheapest highway in original construction cost is not always the most efficient and economical highway to maintain, and it is well for those in charge of design to keep these matters before them when planning for future highways. It often happens that the highway required by traffic conditions in a particular locality cannot always be constructed because of the lack of funds, but there should be no excuse for the official planning the wrong highway when all conditions are favorable. In other words, build the maintenance in the construction of the road. Maintenance work, while it is variable from season to season, can be efficiently executed if properly planned. There are no two roads with similar conditions as to traffic, topography, drainage, etc., and for this reason a special study should be made of the entire road system with the idea of planning for each individual section of the highway. Often, the expenditure of a few hundred

dollars can save thousands of dollars at some later time, and these things can only be found by close observation of all conditions at hand, and by giving due consideration to all the items that will affect the maintenance cost.

In order that a maintenance organization may function efficiently, it must not be tied up in too much departmental red tape. There should be a governing head or body to all successful organizations, but in work which varies as much as the maintenance of a state highway system, the exercising of a certain amount of judgment and discretion must be left with the man actually doing the work and his immediate superiors. The general policies can well be formulated by the governing body, but the matter of details which vary with every locality and with every highway must necessarily be left to the maintenance man who actually carries out the work.

The maintenance work in Wisconsin is carried on somewhat differently than in most of the other states. While the work is under the supervision and direction of the State Highway Department, it is actually done by the county forces and to give the public efficient highway service, there must necessarily be very close cooperation between the counties and state. We are glad to say that this cooperation has been existent from the very beginning and has continued with increasing benefits. It has been our aim to plan the work for the succeeding year at the end of the maintenance season, at which time a representative of the State Highway Department, accompanied by the county commissioner and county highway committee, go over all the state trunk highways in the county and determine the improvements to be made under gang maintenance on each highway. The general maintenance work, of course, is routine and the cost consists primarily of patrolmen's salary, supplies, repairs, and extra help. Gang maintenance work, which may be divided into reconstruction and betterment, requires semi-construction methods and must be planned for in advance. These projects are planned for and a definite amount of money is set up for each project. The county must agree to commence the work on a certain date and have it completed within a certain time. Usually the work is so planned that it will offer the least inconvenience to the traveling public. A good many of the gang maintenance jobs are completed early in the season before the heavy summer traffic starts and some of the work is done in the fall of the year after traffic has decreased considerably. We try to keep the work to a minimum during the months of July and August, which are considered the heavy traffic months.

In all highway organizations, there should not only be cooperation between the man who actually does the work and his superiors, but there should be thorough cooperation between the maintenance and construction departments. If traffic is to be served, it is necessary for those in charge of maintenance to be informed on what the contemplated construction projects are, their location and information as to whether detours will be necessary or not. The great bulk of highway construction is planned well in advance, and by knowing just where the projects will be located for the coming year, detours may be provided and improved by the maintenance forces before the road to be constructed is actually closed. We have followed this policy quite religiously in Wisconsin and can cite many instances where detour roads have been previously widened and surfaced to take care of the through traffic during the construction of the main road.

Spring Maintenance

Maintenance work may be divided into four general classes, as follows: Spring maintenance, summer maintenance, fall maintenance, and winter maintenance. Probably the most critical time in the maintenance of earth, gravel and other light surface roads is in the spring of the year when the frost is leaving the ground. It is true that spring conditions do not show their effect so much on a permanent or durable pavement, but when one considers the fact that the hard surfaced or paved road comprises only a small percentage of the rural highway mileage, the big problem lies in the proper maintenance of the gravel, shale, stone and earth roads. At the beginning of the maintenance season which is usually during the month of April, the ditches must be opened, the culverts cleaned out, the surface graded smooth, and repaired wherever necessary. Objectionable features must be removed from the right of way. At this time of the year it is also possible to do the best work in shaping the cross section of the road. The high places may be cut down and the low places filled. If the patrolman gets a good start in the spring, the

maintenance of his section will not be a great task during the summer season, but if the important details are neglected during the spring, he is bound to have trouble during the summer months when traffic is at its maximum. It is sometimes impossible for a single patrolman to do all the work necessary on his section in the spring, and if this is true, he should be given extra help and in most instances a tractor-grader outfit should be run over his section to open the ditches. The guard fence, rip rap, etc., should be repaired.

Summer Maintenance

After the details of spring maintenance have been taken care of, the patrolman's time is then required almost constantly on the surface of the road. From time to time, he will find it necessary to replenish the surface materials from the stock piles which have been provided. Where traffic reaches 500 or more vehicles per day on the ordinary dirt or gravel road, the patrolman finds that he must keep his grader constantly on the surface in order to provide a smooth riding road. If, for any reason, he leaves the road a day or two, it is very plainly noticeable. One of the important items during the summer months' work is the cutting of weeds along the shoulders, ditches and right of way. In some cases, two cuttings a season are sufficient, but we have found that in many cases it is necessary to cut the weeds and grass as many as four times. The months of July and August require the most intense maintenance on the surface for during these months the traffic is at its maximum. In Wisconsin it is not expected that the patrolman can do much more than keep the surface in a smooth riding condition during this period. Usually, extra work which is required on his section is taken care of by special crews.

Fall Maintenance

In the fall of the year when traffic has decreased considerably, the patrolman will find more time to take care of work other than the surface. At this time the ditches should be opened again and all culverts cleaned out, and the weeds and brush cut from the right of way to prevent snow from drifting on the highway during the winter. Stock piles of materials should be provided at those places where the road is apt to give trouble in the spring. The road surface should be kept smooth so that when heavy frost comes, it will freeze in a uniformly smooth condition. It is very essential that the patrolman continue his grading operations until the ground becomes frozen.

Winter Maintenance

In most states of the latitude of Wisconsin, the amount of winter maintenance done is comparatively small on account of snow conditions. Quite a number of states have adopted systematic snow removal programs and are attempting to give through highway service during the winter months. We believe the time is not far distant when well formulated programs for winter maintenance and snow removal will be put into practice in all states in the snow belt. The demand for through highway service during the winter months is rapidly growing. This is very plainly shown in Wisconsin by comparing the snow removal activities of last winter with that of this winter. During the season of 1925-26 there were approximately 1500 miles on the snow removal program. About $100,000 was expended. Sixty miles of snow fence were placed. This fall $250,000 was appropriated for snow removal work, 275 miles of snow fence were placed, and an increased supply of equipment was purchased. The counties are also attempting to keep all the main highways open to traffic. In the northern part of Wisconsin considerable logging is done during the winter and it is necessary to leave about five or six inches of snow for sleighing. This makes snow removal in the northern counties a little more difficult, but they are giving good service to both the sleigh and automobile traffic.

Highway Safety

One of the growing evils on the highways is the number of automobile accidents which are responsible for upwards of 20,000 fatalities annually on the highways of the United States. Several items contributed to this alarming death rate but most of them show that the driver is responsible. There are a number of cases, however, where the condition of the highway has caused many very serious accidents. It is the duty of every highway worker to do everything possible to eliminate the causes for these accidents insofar as his work is concerned. The proper signing of a highway system does much toward informing the public of the dangerous and hazardous places along the highway. The marking of a centerline on paved roads also tends to reduce accidents. Much

remains to be done in the separation of grades with railroads and also on high speed highway intersections. The dust problem on gravel and dirt roads is a very serious one. The states are beginning to cope with this, but when one considers that 80% of the total rural highway mileage is unsurfaced, it can be readily seen that considerable thought and energy must be directed toward this problem.

Supervision and Coordination of the Work

No activity can be carried to a successful conclusion unless it is properly supervised, and the forces involved properly coordinated. We find that it is impossible to get the best of service from the highway patrolmen unless they are properly supervised and given attention from time to time by a superintendent or foreman. They try to do their best, but when any man is put out on the highway ten hours each day with the small amount of supervision that he ordinarily gets, it is next to impossible to expect efficient results. Thus, by having one who can visit with the patrolman, exchange ideas from time to time, the results will be better maintenance at no increased cost.

County Road Schools

To coordinate the work among the various agencies in the county and state, county road schools are held each year at the county seats, usually at the beginning of the season, in which all subjects pertaining to the maintenance of the highway are discussed. At these meetings the patrolmen are given a chance to speak freely and outline their ideas as learned from experience and to discuss with other patrolmen the advantages of carrying on their work according to the best methods. At this time when all the patrolmen are assembled, general instructions are issued to them by the Commission's representative. Any doubtful points are discussed and agreed upon. The County Road Schools are primarily for the benefit of the patrolmen, but they also serve as a coordinating influence between all those interested in the development of highways.

State Road School

In order to discuss highway problems from a state wide viewpoint, an annual State Road School is held at the State Capitol. The law requires that every county committee and highway commissioner must attend these meetings. All citizens interested in highway work are invited and in many cases do attend all sessions of the Road School. It is believed that the County Road School and the Annual State Road School have been an incalculable influence in the development of the highway system in Wisconsin and have served to coordinate the work of all the counties to the extent that uniform maintenance has resulted throughout the entire state.

Service to All

The above remarks have been directed primarily to state highway systems, but we are frank to say that no state highway system can be successful unless the secondary or local highways experience a parallel growth commensurate with their importance as arteries of transportation. In other words, to give the best service to all of the motoring public from the most remote farmer to the city dweller, it is essential that we have improvements made on the local and county roads as well as on the state highways.

Probably one thing that speaks more for the system employed in Wisconsin than does any other is the fact that county trunk systems patterned after the state system have been developed by all counties, and, in a great many instances, the influence has extended down to the town roads. The county trunk systems today total approximately 12,300 miles of secondary highways which are systematically maintained, marked and signed in the same manner as the state highways. Many of the towns have developed town systems and have placed patrolmen on the highways to keep them maintained at all times. It is believed that the results obtained on the state highway system through the plan adopted have been largely responsible for the development of the county trunk system and the improvement of town roads.

In conclusion may it be stated that it has not been the intention of this paper to cover the many details of the maintenance work which necessarily must vary with each state and locality. On the contrary, the purpose has been to point out a few of the important factors which when properly applied will make for better highway service. It is true that in order to carry these out it requires the expenditure of money, thought, and energy, but after all the amounts expended for maintenance are almost insignificant when we compare it

with what the total investment is in highways and highway transportation facilities.

If we assume that each of the 800,000 motor vehicles owned and operated by the citizens of the state of Indiana travel 5000 miles per year and that through efficient maintenance of the highways each owner is saved one cent a mile in operation of his vehicle, there would be a total saving of $800{,}000 \times 5000 \times 1c = \$40{,}000{,}000$. This looks like a large sum but I believe it is conservative.

I do not know what amount of money is being spent for the maintenance of all rural highways in your state but I venture to say that it is under $10,000,000. Even at this figure you would be saving three times the actual expenditure, say nothing of the added safety, comfort, and convenience which is experienced by the user of the highway. I like to think of maintenance not as an expenditure but as a saving to the motoring public. We must not lose sight of the facts because upon the highway official will rest the responsibility of rendering efficient traffic service. Each has his part to play from the patrolman up to the State Highway Engineer and when thorough cooperation exists between all, then can it truly be said that *traffic is served.*

PROCURING HIGHWAY RIGHTS-OF-WAY

By Connor D. Ross, Assistant Attorney General of Indiana, State House, Indianapolis, Ind.

(Paper delivered at Thirteenth Annual Road School, Purdue University, January 17-21, 1927.)

The laying out and establishment of highways from ancient times has been an important governmental function. The old Roman saw the necessity of the development of a system of improved highways and that system is one of the marvels of history. Paul, in recording the events of one of his missionary journeys, said:

"And we came to Rome and the brethren came to meet us as far as the market Appias."

Why the brethren came no farther than the market of Appias is not recorded, but even in this late day, after years of highway development, I assume that you who are aiding in the great present day movement for the establishment of modern highways know the difference between no road or a mud road and an Appian way and perhaps could hazard a guess.

Under the old English system the establishment and construction of highways was deemed so important that it became a fundamental principle of the common law that "all highways belong to the king and no one shall disturb the king's highway without his consent." This principle has been adopted in a limited sense in the law of our country and state. It is the law of our state that all highways belong to the state, and are under its control, and, of course, they may not be disturbed except by consent of the state, through its legislature.

If then the establishment of highways is important enough for governmental regulation and control, there is nothing in the movement that is more important than the location. If a system of hard surfaced highways is to be established—and this seems to be the goal of the national and state movement—then the location of the roads of that system is perhaps the most important consideration. The citizens of the state before the advent of the hard surface types of construction, have spent millions in locating highways and millions again to relocate in part the same highways. If the present movement is to build permanent highways, we should not forget that, after all, there is nothing more permanent, or, at least, nothing that can be made more permanent—than the location. The procuring of the right of way for highways is therefore the first, an essential and an important step in the establishment or the relocation of a highway.

Methods of Establishing Highways

There are several methods for the establishment of highways. They may be established by prescription, by user or recognition, by dedication to the public by the landowner with the sanction of public authorities, or by statutory proceedings in the exercise of the right of eminent domain. Since the first two methods recognize the existance of a right of way and, in the case of a dedication, the right of way is granted without contest on the part of the landowner, my discussion will be with reference to the procuring of rights of way under the principle of eminent domain.

Under the common law, the king had power to appropriate land for highways without compensation. Under our system, the state has power to appropriate

the land of its citizens for a public use, but with the constitutional limitation that "no man's property shall be taken for a public use without just compensation, nor except, in the case of the state, without first being assessed and tendered." This is known as the power of eminent domain. It is under and by virtue of this provision that most of the highway legislation authorizing the appropriation of land for highways purposes is enacted, and my discussion will deal largely with this principle.

Power of the State to Control Highways

The state, through its legislature, has in the past delegated to its subdivisions —the counties and the townships—and also to cities and towns, the power to lay out and construct highways.

However, these subdivisions and municipalities, in exercising this function of government, act only as agents of the state and their action is limited by the language of the statutes conferring the power. Since the county, the township and the municipality, act only as the agents of the state in this respect, it has been held by our Supreme Court that the state, in its sovereign capacity, has the right to regulate the use of highways, to modify or even to recall the power delegated, or to assume direct control over them.

It was by the application of this principle that the state took over direct control of the highways constituting what has been designated as the "state system" under the State Highway Act of 1917, which was later superceded by the Duff-Buller Act of 1919.

Direct Control by the State

Under this legislation, the state, through the State Highway Commission, has undertaken the direct supervision and control of a system of highways reaching each county seat of the state and every city or town of over 5,000 inhabitants, and connecting with improved trunk highways of adjoining states.

Section 23 of the act of 1919 confers the power upon the State Highway Commission to change the location of a state highway or to deviate from the location of a highway taken over as a part of the state system, in order to shorten distance, to eliminate steep grades or sharp turns, to widen narrow portions or otherwise to promote public convenience and safety. To make effective this grant of power, section 24 of the act confers power upon the commission, in the name of the state, to acquire lands and rights by purchase or by voluntary grants and donations for any of these purposes and also for the clearing and removal of obstructions at highway crossings.

This section also confers directly the power of eminent domain. This provision, like all legislation on the subject of eminent domain, requires as a condition precedent to litigation an attempt to agree on the part of the commission with the landowner either as to the purchase price for the land, or as to the damages sustained by the landowner by reason of the appropriation.

Proceedings Under Power of Eminent Domain

While there are several methods of laying out county highways, most of which involve to some degree the power of eminent domain, the counties and the municipalities of the state are expressly given the power of eminent domain. The County Unit Act expressly confers the power of eminent domain on the boards of county commissioners, which power is exercised in all essential particulars in the same manner as prescribed in the State Highway Act, except that the boards of commissioners act instead of the commission.

In case the State Highway Commission is unable to agree with the landowner, the commission may pass a resolution setting out such fact with a description of the land and refer it to the Attorney General. It then becomes the duty of that official to bring condemnation proceedings to appropriate the land required.

The legal department of the state, however, has no express power or duty as to the selection of the route of a state highway. This power is to be exercised within the discretion of the commission. Whether the designation of a particular route is wise or unwise, the legal department is glad to leave the decision of that question where the law places it.

The exercise of the power by the commission has entailed much litigation, and various questions, some with little or no merit, have been presented in proceedings instituted for the procuring of rights of way.

These questions in my judgment, when analyzed, present no new principles, but demonstrate merely an attempt to make new principles out of the rearrangement of the same facts without change of substance.

Nature of Proceedings—Procedure

The proceedings to appropriate land for a public use are summary in character and the statute prescribing the procedure is designed to enable the public officials having charge of a proposed public improvement to obtain possession with precision and dispatch. Hence the statute provides for a proceeding for the appointment of appraisers, and, in view of the spirit of the statute requiring speedy action, it has been held that a change of venue from the county at this stage of the proceeding is not contemplated. The statute requires only that the complaint shall set out the name of the body desiring to condemn; the name or names of the parties having or claiming an interest in the property; the intended use of the property; the location, width and termini of the right of way; and that the plaintiff has been unable to agree with the owner or owners for the property as to the purchase price or upon the amount of damages.

These elements of the procedure would not be of interest to those engaged in the actual construction work upon highways, except that concerning the description of the property to be appropriated. To avoid any question as to the description, it is always advisable to describe fully the property to be condemned; since parties desirous of hindering the progress of construction often seize upon the slightest pretext to accomplish a delay. However, the courts have held that a description is sufficient that will enable a skilled engineer to locate the land to be condemned.

The requirement as to the failure to agree is also a favorite point of attack. This requirement is designed merely to avoid litigation, but sometimes an attempt is made to magnify its purpose by reading into its meaning niceties that the lawmakers never intended. The courts have held that the condemnor is not compelled to go further in an attempt to agree than to disclose the fact that an agreement is impossible; but in making the offer the landowner should be appraised of the amount and description of the land to be condemned and the purpose for which it is to be used. There are instances, however, in which an attempt to agree is not even required. If the landowner denies the power of the condemning part to appropriate the land, the law treats the matter of negotiation as a useless ceremony and an attempt to agree is unnecessary. Or if the landowner refuses to sell at any price, a specific offer is not required. It has even been held that the sending of a letter making an offer to a landowner, to which no reply is made is sufficient to satisfy the requirement as to an attempt to agree.

Upon formal proof of these facts required by statute, the court is warranted in appointing appraisers, and there is rarely a failure to make the appointment after the hearing of the usual objections. In the experience of the state legal department, no court has as yet refused to appoint appraisers and in several instances the proceedings have been bitterly fought.

The appointment of appraisers amounts to a finding that the condemnor is entitled to appropriate the land and, upon payment of the award to the clerk of the court, the condemnor may take possession of the land condemned and proceed with the construction work.

It is doubtful whether the state is even required to pay to the clerk the amount of the award before taking possession in view of the constitutional provision that makes an exception in favor of the state as to the assessment and tender of the amount of the compensation. The purpose of the constitutional provision requiring payment of the compensation in advance is to protect the landowner against corporations of doubtful solvency, but since it is a presumption in law that the state will always deal justly with its citizens, and in view of its unlimited power to raise money to discharge its obligations, the courts have held, under this provision of the constitution, that a state may take possession of the property before the amount of the compensation is actually determined by the court. The practice, however, has been to pay to the clerk the amount of the award before the taking of possession; but, in many cases, the clerk upon motion is ordered by the court to retain custody of the fund pending an appeal from the award.

Since the proceeding for the appraisement of the damages is merely summary in character and designed merely to effect a settlement of the controversy without extended litigation, the statute provides for an appeal from the award of appraisers by either party, but, in case of appeal to the court appointing appraisers, there is but one question to determine—the amount of damages sustained by the landowner. The question

as to the right to condemn and kindred questions are settled in the preliminary hearing.

Trial On Appeal from Award

The proceeding before the court on appeal from an award is more formal in character and is what it purports to be—a trial before the court in which a jury may be demanded. The trial before the court is *de novo* or a trial anew, and not merely a review of the preliminary proceeding. The manner of determining the damages is similar to other actions for damages to property and the measure of the recovery is determined by the difference between the fair market value of the entire tract of land involved immediately before the appropriation and the fair market value of the remainder immediately thereafter, assuming the highway to have been constructed as of the date of the appropriation.

The Necessity of the Appropriation

One of the questions that has frequently been raised is that of the necessity of the appropriation. This question is usually inspired by a dissatisfaction with the route selected by the highway officials and the litigation based thereon has at times been fostered by persons not parties to the proceedings. The lawyers who seriously assert the proposition that a landowner has a right to raise the question of the necessity for the taking of the land confuse, as I see it, the principle of eminent domain with the act governing the laying out of highways by subdivisions of the state in which the question of the public utility of the proposed highway is involved. The reason why the question of the public utility of the highway may be raised under such acts is that the establishment and control of highway is a legislative function, and, the legislature has expressly conferred the right. The law and similar laws conferring the right to raise the question of the public utility of the proposed improvement have been in the books so long and the right exercised so frequently that many people have become embued with the thought that the power to raise the question exists as a matter of right. The fact is, however, that the right exists by grant from the state, through its legislature, the source of all rights and duties for the control of highways.

In the laying out of highways under the power of eminent domain as prescribed in the State Highway Act and similar acts, there is no right of a hearing on the question of the necessity of the taking of the land. This is a question solely within the discretion of the highway officials. The decisions of our Supreme Court, involving purely the application of the power of eminent domain, have improvements are necessary or upon what particular plan they shall be made. In one of the leading cases on the subject, our Supreme Court used this language:

"Where the use is public in its nature, the question as to the necessity for taking private property in a particular instance by virtue of the power of eminent domain is, in its essence, a legislative question * * *. The taking of land for a public highway affords one of the clearest illustrations of an appropriation for a public use. * * * The test is, not how many people do actually use them, but how many have a free and unrestricted right in common to use them."

Another source perhaps for the confusion of laymen and lawyers upon the subject is the old laws governing the laying out of highways on the assessment plan. This plan, however, it should be borne in mind, is a combination of the state's power of taxation through special assessment with the power of eminent domain. The method of establishing public improvements under this plan is based on the theory that the total land affected is benefited to the extent of the total damages or the improvement may not be constructed; otherwise there would be no means of paying for the improvement. In such cases the landowner, of course, has a right to a hearing as to the utility of the enterprise, because, if the improvement is to cost more than the resulting benefit, it is not of such public utility, under such acts, as to warrant the expense. But in relocating and constructing highways under provisions such as contained in the State Highway and County Unit Acts, the state acts in its capacity as a sovereign and the right to appropriate turns upon another theory, in the application of which the public utility of the enterprise is determined without a hearing on the part of the landowner. Since in the establishment of highways under this theory, the land owner is to be paid for the land taken and the incidental damages, without assessment, he may not raise the question of public utility, so long as the property to be condemned is for a public use.

Just Compensation—Elements

What constitutes just compensation within the meaning of the constitutional provision prohibiting the taking of private property for a public use? Must the public, in the laying out and construction of highways under the power of eminent domain, pay *in money* for the land actually taken, for the incidental damages for the building of fence to enclose the remaining land and any other expense occasioned the landowner? If the public must pay in money for the property taken and for the incidental damages and expense, then the benefits, resulting from the construction of the road, if any, such as the transportation facilities afforded by an improved highway, the increase in value of the land or in its rental value, the making of the land adaptable for purposes other than that for which had formerly been used, or the making of it salable in parcels, is clear gain on the part of the landowner.

The courts of this state, however, have consistently held that benefits may be considered in fixing the amounts of compensation in all highway cases brought under the eminent domain act.

The principle that benefits may be taken into consideration had received the approval of the Supreme Court before the enactment of the eminent domain act of 1905, which is now in force. In an early case on the subject, the Supreme Court, speaking through Judge Elliott, who was an authority on highway law, said: "It may possibly be correct to hold that where benefits cannot be taken into consideration, as in the case of appropriations for railroad purposes, the question cannot be asked a witness as to the value of land without the railroad and what it would be with it. * * * A careful examination of the books and cases have satisfied us that where there is no law excluding benefits * * * or where the question is one effecting the right to assess benefits, a witness may state his opinion of the value of the land without the proposed highway and its value with the proposed highway."

Measure of Damages

Therefore, before the enactment of the act of 1905, the measure of damages for the land taken for highway purposes was the difference in market value before the taking and the value after the taking. This being the rule, it would be impossible for a court to successfully hold that benefits may not be taken into consideration in considering the amount of damages resulting to the landowner by reason of the appropriation of land for highway purposes in the exercise of the right of eminent domain.

The principle announced by Judge Elliott was consistently adhered to by the courts in construing the constitutional provision relative to the taking of private property for public use and in construing county highway acts that involve the principle of eminent domain, prior to the passage of the eminent domain act of 1905.

The Supreme Court in proceedings brought under the act of 1905 has also adhered to the principle announced in the opinion written by Judge Elliott. In an opinion involving the laying out of a highway under the county highway act of 1905, the Supreme Court approved an instruction given by the trial court which was in part as follows:

"The constitution of this state provides that no man's property shall be taken by law without just compensation, but it is the law of this state, as applied to the location of public highways, that benefits, derived by reason of the laying out of a road, may suffice to constitute just compensation for land taken and appropriated for a road, within the meaning of the constitutional provision requiring such compensation to be made."

The confusion that arises as to whether benefits shall or shall not be considered in such cases often arises from a failure to distinguish between railroad or similar corporations and political organizations, such as a state, a county or a township.

The reason is clear why benefits are not taken into consideration in the appropriation of land for railroad or similar purposes, since one whose land is taken for railroad purposes is not benefited to any greater extent than other persons in the community. A highway may be a special benefit to the landowner for the reason that it may furnish him peculiar benefits that attach to the land in the way of transportation facilities or an opportunity for the sale of land in parcels. This is not true in case of the taking of land for railroad purposes.

The fact that other persons living along a proposed highway will be benefited by its construction affords no reason why benefits should not be deducted in

a particular case. Judge Elliott in his valuable and exhaustive treatise on the subject of "Roads and Streets" used this language:

"Although other persons upon the line of the highway may also be benefited by its opening or by its being widened or improved, the benefit which the adjoining owner of one or more parcels of land receives from the opening of the highway is considered peculiar to him and not one enjoyed by him in common with the general public."

There is no merit in the argument that benefits should not be considered in laying out and constructing state highways for the further reason that the same argument could as well be made against the consideration of benefits in the laying out of county or township highways or city streets.

Indeed, the legislature has gone so far as to authorize an assessment against abutting property in proceedings for the laying out of county and township highways and city streets. This legislation is on the theory that the adjoining property is peculiarly benefited by reason of the construction of the highway. If adjoining lands may be assessed under such statutes for this purpose, it follows that no sound argument could be made against the consideration of benefits against the landowner who is not to be taxed by the method of special assessment, nor could it be argued with any degree of confidence that the legislature intended that one thus favored should be further favored by withdrawing the principle announced by the courts as shown in the opinions to which I have referred.

The reasons which authorize the consideration of benefits are conclusive when construed in connection with the rule announced by the courts for the fixing of damages to which I referred. It has been repeatedly held by the courts that the measure of damages in cases of this character as held in the opinion written by Judge Elliott, is the difference in market value of the land affected before and after the appropriation. If the land affected has been increased in value by reason of the lying out and construction of the highway, there is no escape from the conclusion that the landowner has been specially benefited. The Supreme Court in a later opinion written by Judge Elliott used this language: "The conclusion to which the authorities lead is, that benefits are special when they increase the value of the land, relieve it from a burden, or make it especially adapted to a purpose which enhances its value."

Another conclusive reason why the fifth clause of section 6 of the eminent domain act of 1905, which authorizes deduction for benefits, applies to the taking of land by the state in highway cases is that the state highway act itself provides for the taking over by the state of roads formerly controlled by the counties; and, as I have stated, the decisions hold that benefits may be considered in county highway proceedings under this provision of the eminent domain act. If the state through its commission may take over a county highway for construction and maintenance and may thereafter relocate it, it necessarily follows that the same principle as to the consideration of benefits should be applied to both the state and its subdivisions. Otherwise a result could be accomplished by indirection that may not be accomplished directly. If, in the laying out and construction of a county highway, the county may have the advantage of applying the principle that allows deduction for benefits, then the state through its commission could effect an agreement with a county, as authorized by the State Highway Act, under which the county could re-locate a highway prior to its being taken over by the commission. In that event the benefits could be taken into consideration in fixing the compensation due a landowner. The commission could then take over the highway and accomplish the purpose of having benefits considered. This would mean that merely the time at which the land is taken for highway purposes determines the question of whether benefits may or may not be considered.

Every rule of reason or construction is in favor of the principle that benefits may be taken into consideration in fixing compensation under the eminent domain act in the establishment and construction of highways.

The landowner is entitled to just compensation for the land taken and for the actual incidental damages to his remaining land. The elements of damages, however, must be actual and susceptible of proof and not such as are merely speculative or conjectural.

Prospective annoyance from the use

of a highway in a lawful manner may not be considered as an element of damage. No allowance may be made for injuries that are not peculiar to the estate of the owner and all losses, if any, that are suffered in common with the public generally are deemed strictly consequential for which no compensation may be awarded. It has even been held that, where the laying out of a new highway necessitates the building of additional fence to enclose the remaining land, if it appears that the building of the fence increases the value of the land to the extent of the cost of the fence, the court or jury would not be warranted in considering this expense as an element of damages.

The great majority of landowners recognize the value of an improved road, and, while the legal department of the state during the past four years has brought perhaps 500 condemnation proceedings, an exceedingly small number of these have proceeded further than the report filed by appraisers; and a greater number have perhaps been settled by the highway officials by negotiation.

The landowner sometimes has a real grievance. But whether he does or does not, there is no escape from the fact that his land may be appropriated only in the manner prescribed by law. No one can deprive him of his day in court and counsel for the public cannot always control the progress of the proceedings. For this reason, although it has been held that in view of the public's right to the exercise of eminent domain, contracts may be let before the procuring of the right of way, it is advisable that, to prevent delay in construction, officials and engineers in laying out highways take into consideration the legal phase of the procedure.

The questions that I have discussed are those that usually arise in case of contest, in the procuring of the right, of way and in the assessment of resulting damages. There are other questions, however, that often arise involving the right of control and regulation of highways that are equally important. The rights of a railroad or interurban company to occupy a highway with its tracks and the duties of such companies as to grade separations and highway crossings are of this character.

Each of these questions is controlled by the principle to which I have referred—the right of the state to regulate and control its highways. It is fundamental that the state never surrenders or contracts away its right to legislate in the interest of the safety and convenience of its citizens. Therefore, when a railroad or other public utility company constructs its tracks or equipment upon or across a highway, it subjects itself to the state's right, through its officials or political subdivisions, to cause the tracks or equipment to be moved at its own expense from the side to the center or from the center to the side, of the highway in the interest of the safety or convenience of the public. It was formerly the law that such companies were also required, when necessary for the public safety, to construct and maintain grade separations at the crossings of railroad and highways. This law has been modified to an extent, and under the present statutes the public has assumed a portion of the cost of grade separations. These companies also construct and operate their railways subject to the state's right to extend highways across them, and the law casts the burden upon such companies to construct and maintain the crossings at their own expense in such manner as to insure the safety of the traveling public.

In the early history of our state, the fathers, in laying out roads, followed the rule that "a straight line is the shortest distance between two points," and some of our main trunk roads were established under that principle. The railroads then came along, relieving the highways of the "long haul" or the long "drive," and consequently there was a change in the manner of laying out highways. The old National Road, which had been constructed through Indiana from Cumberland and which was to end at St. Louis, became lost in the swamps of Illinois. Railroad development had overtaken it, introducing the "long haul" by rail and only the "short haul" was left for the highways. Highways, following the advent of the railroad, were then located and relocated upon section lines and in such manner as to prevent the cutting of farms.

The hard surface type of construction of highways and the advent of the automobile and tractable truck have again wrought a change. The tendency in the construction of highways is to swing back to the old idea of the fathers. This tendency has entailed a heavy work upon both state and county officials engaged in highway construction and upon their

legal representatives. The co-operation between the federal, state and county officials has been efficient and helpful. In the continuance of this co-operation lies the hope of the greatest highway system of the world. It will mean the passing of the "mud" and rough road tax and, if the poet's version of the Bible is correct, will insure our eternal bliss, although it will kill the inspiration that caused him to sing his "Epigram on Rough Roads":

I'm now arrived—thanks to the gods,
Through pathways rough and muddy,
A certain sign that makin' roads
Is no' these people's study;
Although I'm not wi' scripture cram'd
I'm sure the Bible says
That heedless sinners shall be dam'd,
Unless they mend their *ways*.

BRIDGE SURVEYS FOR NEW STRUCTURES

By W. W. Hadley, Engineer of Bridge Construction, Indiana State Highway Commission.

(Paper delivered at the Thirteenth Annual Road School, Purdue University, January 17-21, 1927.)

The topic assigned to me, "Bridge Surveys for New Structures," should, from the different variety of survey notes I have seen, cause a heated and lengthy discussion. Survey notes that I have had experience with have been of many kinds, ranging from some notations on the back of an old envelope giving the difference in height from the bed of stream to the crown of roadway, to a most complete set compiled in a notebook, accompanied by photographs giving all the information desired.

The purpose of a bridge survey is to secure a set of notes to be used in determining the length and location of the proposed new structure, by the designer in completing a set of plans to fit the situation at the bridge site, and by the estimator in estimating the cost of the proposed bridge.

The importance of the Bridge Survey is under-estimated by a large number of engineers, and especially, by the younger members. Most of the young engineers, upon graduating from a technical school, wish to get a start either in the drafting room, or on construction, and are rather disappointed if you offer them an opening as assistant on a bridge survey party. Work on a bridge survey party is a splendid foundation for later experience either in the drafting room or on construction. An incorrect set of survey notes may, and generally does, require a revision of plans during construction, that may prove a costly delay, and an additional cost in getting the structure completed. It frequently happens that upon the result of the bridge survey depends the location of the road. An ideal chief of survey party is one who has a working knowledge of construction and design, in order that he may know what phases of the survey to pay the greatest attention to.

I well remember my first bridge survey, and the old adage is true: "Where ignorance is bliss, 'tis folly to be wise." About the only qualification I had was the ability to run a transit and level. Fortunately, I was working in a small organization with headquarters close to the proposed bridge site, and when information not shown in my notes was needed, I was able without much expense or loss of time, to get the information required. It took several extra trips, however, to get what I could have secured in my first day's work. The total amount of information secured was not nearly as much as I would get now, however, and much was assumed by the designer that should have been investigated. The structure afterwards built has stood several floods, but I do not wish to discuss the economy of the design or what could have been saved by more time spent in getting ready to start the plans on the bridge.

In small organizations, where the responsible head in charge of the bridge work, may have an intimate knowledge of the bridge site the survey need not be as comprehensive as in a large organization, but it is advisable to keep the notes taken, in a field book to be filed away when the plans are completed. During construction, questions may arise in which it is desired to know the reason for certain features of the design, and if a copy of the original survey notes are available, such reasons are generally very evident.

In a large organization, when the designer and estimator do not see and are not familiar with the bridge site, the survey notes must be complete, in order that nothing is left to be guessed at. It has been found to be a big help if the survey notes are accompanied by photographs showing the site at the time the survey was made.

In making the survey proper, the first step should be the establishment of the center line. If the structure is on a new location, the survey notes for the new road are available, and this reduces the amount of work necessary by the bridge survey party. If, however, the structure to be built is on an established road, it is necessary to locate the center line of the existing road. We have found from past experience, that it is always necessary to continually caution the chief of the survey party to get information as to the alignment and grade of the road from ¼ to ½ mile on each side of the structure, depending, of course, on the topography of the vicinity. Nowadays, the traveling public is very prone to take the existence of good roads and bridges as a matter of course, and thinks that somebody should be able to wave a magic wand and say "presto change," and have a new bridge all ready for traffic without inconvenience in any way. We, of the bridge department, probably know better than anybody else the amount of criticism that we have been subjected to on account of bridges being out, and traffic being required to detour. For this reason, we always endeavor now, if it is at all possible, to locate the new structure on the center line that is far enough to one side of the old bridge to allow for the old structure to be used until the new structure is built if it is taking care of traffic at the present time, or in case of complete failure, we are frequently able to build, at a small expense, a temporary bridge on the old abutments and piers. However, the approaches to the bridge may be on high embankments and careful consideration should be given to utilize such work in place whenever possible. It frequently is advisable to establish a base line to get the topography and leave the final selection of the center line until the notes have been plotted and all angles of the situation considered. After the center line or base line is established, it is very essential that it should be referenced out with permanent references, in order that the center line of the survey may be exactly reproduced at the time construction starts. During the first year or two of the organization of the bridge department, most of our bridge surveys were made by separate survey parties, not in charge of construction, and we were continually receiving complaints from men in charge of construction that they were unable to find the reference points. It was very easy to establish reference points on telephone poles, and then when the pole gang came along and moved the poles, the reference points were of no use to the construction party. The information secured by these parties not always being accurate, it was a favorite topic for the construction men to complain of the kind of work done by the survey party. Partly to relieve this condition, we endeavored for a while to have all surveys made in the winter time, during the slack period of the construction season, by the same men that would be responsible for the construction of the new structure. In this way, when we got a long distance telephone call from the construction man that he was having difficulty on account of sub-soil conditions not being the same as shown on the test pits, our first question to him was, "What was the matter with the information secured by you?" After the center line has been established, the next step is to take, either by cross sections or stadia, enough information in order that a complete topographical map showing the bridge site may be made up. There should also be taken, if at all possible, a profile of the bed of the stream, 50 ft. or so on each side of the proposed structure. The next step in the bridge survey should be the putting down of the test pits or some other method used to determine the sub-soil condition at the bridge site. On this subject, I would like to have a good deal of discussion relative to the best methods that have been found practical in obtaining knowledge of the sub-soil. Ordinarily, we ask our field party to put down test pits with shovels as far as possible, and then we have found by experience that the most effective instrument is a common post-hole augur to which may be screwed lengths of pipe, and the augur turned with two 24″ Stillson wrenches. In some cases, we have to secure information as far down as 12 or 14 ft. On some of our larger jobs, where it is of vital importance to determine the sub-soil condition to an accurate degree as possible, we have gone to the expense of letting a contract to a wash-boring outfit, but our experience with this kind of information has not been altogether satisfactory. On one of our jobs a few feet below ground level, the wash-boring showed the sub-soil to be a soft sandy clay. During the construction of the bridge, when the contractor got down

with his excavation to the level as shown in the test pits where this material would be found, it was necessary for the contractor to remove by means of dynamite, a very hard sandy clay. By placing some of this clay in water, we got a soft sandy material such as described in our inspector's report. Evidently, the churning of the drill and the water loosened this material so that when it was examined, it was of an entirely different nature than in its undisturbed condition. On the one job in question, after going through this hard material for a depth of 4 or 5 ft. and encountering a soft strata, it was necessary for the contractor to drive longer piling than was specified on the plans. I recently noted an article in "The Engineers News Record" which shows that other engineers have been having the same experience with wash-boring outfits. In New York City where they were going to construct a new building, they had some extensive explorations made by wash-boring outfits, and the contract for the foundation was made on a basis calling for approximately 360 cubic yards of hard material. When the top soil was uncovered, it was found that the wash borings were in error and the contractor was paid on his agreement for approximately 4500 yards of hard material. The nature of the sub-soil condition determines to a large extent, the kind of equipment that the contractor will place on the job and his basis of the unit price that he bids. Of course, our specifications and contracts require that the contractor make personal inspection of the bridge site, in order to definitely assure himself that the information given on the plans is correct. But we all know that the majority of the contractors do nothing more than make a superficial examination of the bridge site. It is excellent practice to stake out the foundations as soon as a temporary lay-out is made and put down test holes, one on the center line of the bridge, and one at each end to check the information as given in the survey notes. In addition to recording the information given by putting down the test holes, the chief of party should note the bearing value of the subsoil that will be directly below the footing. A short excursion should be made a short distance up and down stream from the bridge site and a notation made as to the scouring propensities of the stream, and also the material composing the bed of the stream. The survey notes should give the necessary available waterway necessary and this recommendation is in some cases the most difficult for the chief of party to make. It is often very hard to determine whether or not it will be advisable to make the structure large enough to carry a certain percent more flood water than has come down the stream in the past. If the road is one that is subject to overflow at a great number of places, and due to excessive cost, it is not advisable to raise the entire road above the flood stage, it is foolishness to build a structure that will take care of maximum flood condition, for if the road is out of use, there will not be very many people use the structure. Care should be taken, however, to place the foundations to such a depth that they will not be undermined during the flood condition. The high water elevation should be determined and it is advisable to give the elevation of both the average and maximum high water. This information should be secured from several, and we wish to emphasize the *several* citizens of the locality, and the citizens should also be interviewed severally as we have found there is a wide variance in memories relative to high water. Other structures up and down stream should be visited and the available waterway measured. Of course, in case the adjacent road is flooded at times the area under water conditions differing, should be added to that under the bridge, in order to get the effective waterway required. After a checkup has been made of the existing structures on the same stream, and an allowance made for the difference in the drainage area, we have found it to be advisable to make a check of the number of acres in the drainage area up stream from the proposed new structure, and then by the use of Talbott's Formula to determine the necessary amount of waterway required. If, after checking the size of the adjacent structures, we find that our recommendations from this source is checked by the information given by Talbott's Formula, we feel safe in making our recommendations. We frequently find, however, that the information given by Talbott's Formula does not check at all with the structures that carry flood water conditions. This is especially true in flat country in the northern part of the state in the lake area, and also in the southern part of

the state where it is hilly, and we have a very quick run-off.

After the strictly survey part has been completed and the notes recorded so that an accurate layout sheet may be drawn up, the sub-soil condition determined and the effective waterway required determined, the most important part of the survey remains to be completed, that of making recommendations relative to the new structure. From the knowledge gained by the actual survey work, the chief of party has become thoroughly acquainted with the site and should have in mind the size and type of structure that will fit the location. A recommendation should be made as to the type of structure, the clear span, the location of the face of abutments, the center line of piers, and the type of wings at each corner of the abutment that will best fit conditions. If it has been impossible to locate the structure so that it will not interfere with the flow of the stream, a recommendation relative to the placing of rip-rap should be made to prevent a scour around the wings or piers. A note should be made as to the availability of any material that could be used as rip-rap. If an old structure is being replaced, there will ordinarily be material from the old substructure that can be used to advantage.

One of the questions the designer will ask is whether or not piling will be required. From the investigation of the sub-soil condition and the notes made relative to the scouring propensities of the stream, a decision can easily be made if piling should be required and of the proper length. If the stream banks show no evidence of scour but the old structure has not been carrying all the flood water that the new structure will, due to the improvement of the adjacent road, particular attention should be paid to the nature of the stream bed and whether during a flood condition where a head of water may exist for a short time, there will be a scour in the stream bed between abutments. Piling is frequently necessary where a scour may occur, even in soil that undisturbed has the required bearing value. A note should also be made as to whether or not piles are available locally or it will be necessary to the contractor to ship them in. If they can be secured locally, the price per lineal foot delivered to the job should be noted for the benefit of the estimator.

A recommendation should be made as to the elevation of bottom of each footing that in the opinion of the chief of party will be advisable. If a truss, girder, or arch, is called for, the proposed elevation of the low steel, bottom of girder or intradose at the crown of the arch should be given.

For the use of the estimator, the nearest shipping point and the distance to it should be given and any other information given that has been secured that will be of benefit in arriving at estimate of the cost of the new structure.

As in most cases the contract for the new structure requires the removal of the old one, the survey party should get the necessary information relative to the old structure, so that an estimate may be made of the cost of the removal. If the old structure is a steel truss enough dimension should be taken so that a fairly accurate estimate can be made of the weight of the old superstructure. It may be of interest to you to know that we are now asking the contractors to bid on the old steel superstructure. If they give us a satisfactory bid, the old steel is sold to them and can be removed in any manner they see fit. If not, they are required to match mark the structure and use care in removing it, piling the material within 500 feet of the bridge site, in which case it has to be disposed of by us. Most of the contractors have found it to their advantage to buy the old steel and remove it in the easiest possible manner. This saves us the cost of disposing of it and the liability of having it stolen.

The survey party is requested to make a recommendation as to how traffic can be taken care of during the construction of the new bridge. The length of the available detour is measured and noted and the condition of the detour roads. As stated before, if possible and economical, it is good policy to make a slight relocation so that the old structure may be used until the new one is completed. If this is not possible the adjacent land owner is interviewed to see if right of way can be secured for a run-around, provided a temporary bridge is feasible. If so, the cost of the temporary bridge is estimated and recorded. In some cases parts of the old structure can be utilized, such as stringers, I-beams etc., so that a temporary bridge need not be expensive. In case such material is not available, native timbers can frequently be used at small cost and

a timber trestle put up that will serve until the new structure is ready for traffic. Where it is at all possible to do so, and where the cost is not too great, a temporary bridge and run-around should be provided.

In conclusion, I wish again to emphasize the importance of the bridge survey as an essential factor in the work toward the building of a structure, the points to be covered by the survey to be determined by the familiarity of the site, requirements and conditions by the designer.

In any organization, to be able to produce a well kept set of survey notes, giving the information on which the design and location of the structure were based, is a valuable asset. In the event after the structure is completed, it is necessary to defend the design, a clear set of original notes to refer to repays for all the time spent in keeping records that may never be used after the structure is completed.

SNOW REMOVAL ON COUNTY ROADS

By W. M. Tonkel, Wayne County Highway Superintendent, Ft. Wayne, Indiana.

(Paper delivered at the Thirteenth Annual Road School, Purdue University, January 17-21, 1927.)

The topic assigned me for this Road School is the problem of Snow Removal. Dealing with snow, to me, is a very serious and unwelcome condition that we of the Northern part of the United States must give a great deal of thought.

Years ago, before many of the roads were paved and before the time of the automobile and truck traffic, we hoped that snow would fall on our roads so as to fill the ruts that had been cut by thawing and smooth the road over in general so that the old fashioned bob-sled and cutter could be taken out and used.

However, time changes everything and it is very important at the present time that snow be removed from the road as quickly as possible after it has fallen. We do not see many bob-sleds and cutters any more. Progress has given us the large freight trucks and passenger automobiles that must have a clear right-of-way to their point of destination.

Many of our freight trucks and bus lines are working on a time schedule and this time schedule is based upon ordinary conditions, and it is up to us as road men to see that this schedule is carried out with the possibility of a free road.

There are various problems to the removal of snow and one of the most serious, in my opinion, is the snow drift. To solve this problem it is necessary to give it a study from the experiences of preceding winters. For instance, snow drifts deeper in some places than it does in others and there is a reason for deeper drifts and it is necessary to locate this condition the winter before so that preventative methods can be applied prior to the snow season.

A snow drift will usually take place where the wind is checked by some obstruction. The snow is deeper in drifts for the same reason that sand bars are formed in streams where the current in the water is not strong enough to carry the sand and silt, thus allowing the sand and silt to drop to the bottom.

We usually find snow drifts more frequent on our north and south roads. This is due to the prevailing direction of our winds which are generally from the west, together with the fact that obstructions such as fences, hedges, etc., are usually found paralleling road. Therefore, an obstruction on the west side of the road is much more objectionable than one on the east side.

You will find that wherever there is a snow drift that such things as a rail or picket fence or hedge fence are on the side of the road that checks the current of air just enough to let the heavier particles of snow drop.

Hills or high banks are often the cause of snow drifts. A careful study of the cause of snow drifts during the preceding winter will be of great value in solving the problem for future winter seasons. It must be kept in mind that the direction of the wind is a controlling factor in the location of drifts. Snow drifts cannot always be eliminated. Neither can a heavy fall of snow be prevented and this compels us to deal with the subject later from another point of view.

The removing of obstructions which cause drifts can be determined, as I said before, by preceding winters. This frequently can be done by having low trees trimmed some distance from the ground and fences which cause this con-

dition can be discouraged from use by the farmer. However, we cannot always in justice to the farmer tear down fences he has built at this particular point. However, the seriousness of the case will frequently justify the removal of certain objectionable fences and a wire fence might be suggested and built at this particular place.

A board, picket or hedge fence should not be closer to the center of the highway than one hundred feet. This will give plenty of room in most cases for snow to settle before it touches the highway. Weeds and brush on road shoulders or outer edge of right of way should be kept cut and trimmed. The higher the road bed the less will be your trouble from drifting snow. Hence, in designing a great deal of consideration should be given this feature. In constructing a road it may be elevated at the point where drifts are likely to form.

Of course we will not always be able to remove a hill which happens to be the cause of snow drifts. There is one way to prevent such drifts in this case and that is the erection of snow fences or snow gates, as some call them.

Now in some cases it is advisable to erect a stationary snow fence, but in other cases it would be an injustice to the farmer to take up certain parts of his land for this purpose which would hinder him from using same for the growth of crops.

In this instance I would suggest a portable fence, a picket fence with pickets placed close together may be temporarily constructed for this purpose and can readily be removed, for it can be detached from its rails and laid away until the next winter.

There are various methods of removing snow from the road. First, the use of a snow plow pulled by horses or tractors or attaching same to the front end of motor trucks. My suggestion on this would be to start the plow down the center of the road and open up traffic as quickly as possible and then return and throw the snow from the sides as far over into the ditch as possible.

An ordinary grader is an excellent machine for scraping snow from the highway, iron shows being placed under the blade to prevent gouging in the pavement or catching some slight projection in the road surface. The use of a heavy grader is desirable so as not to be shifted sidewise when under heavy load. A "V" shaped snow plow is often used for opening up tracks in road. This can be used where depth of snow is too great for use of road grader. It will of course be necessary to use enough horsepower to pull both the grader and the plow through the deep snow. A snow plow attached to the front end of a motor is used to a considerable extent but it cannot be made to operate in very deep snow or drifts as in the case of the road grader and the horse. There is also the power driven rotary sweeper, similar to that used by electric railways to clean their tracks. Owing to the fact that there is a great demand each year for cleaning snow from the road it is possible that machinery will be developed for each specific case in the near future.

It is my experience that there is nothing at the present time that can deal with the 5 or 6-ft. snow drift excepting by some kind of a snow plow, that is, driven by some kind of a caterpillar tractor. However, these drifts are not too frequent and in such places a track made just the width of the road and then working out the sides with other machinery can be employed. My suggestion of course at all times is to clear the road from berm to berm of any snow on the surface, because it is quite dangerous to expect traffic to continue down one track of highway and in most cases where the approaching machine turns out for the on-coming machine they are liable to skid or otherwise lose control of their machines. Throwing snow completely over into the ditch is another important feature because when this snow melts it is less apt to depreciate the berm.

It has been our experience that the expense of snow removal in Allen County by use of the old method of hand labor was enormous as compared to the cost of the present time. I would estimate that in 1918 we paid approximately $15,000.00 for the removal of snow, but by the use of preventative methods, as well as the result of procuring machinery for this purpose, we have been able to reduce the figure to not more than $2,000 per season.

The one thing that must stand out most prominent is the necessity of using preventative methods.

Of course the question of snow removal is of vital importance only to those who are geographically situated where snow falls in quantity, in the

northern part of the state, but it should concern each and every one of us, for we may not always be in the same location throughout our lives, and knowing what to do if confronted with problems of this sort is very advantageous to the success of a good road superintendent.

NEW CARLISLE, INDIANA, GRADE SEPARATION

By P. R. Gillin, Civil Engineer, South Bend, Indiana.

(Paper delivered at Thirteenth Annual Road School, Purdue University, January 17-21, 1927.)

In the summer of 1912, the Lincoln Highway Association laid out and established the route of the Lincoln Highway across St. Joseph County. The route chosen was over the old Vistula Road from the east county line into South Bend and from South Bend west through New Carlisle to the west county line over the old Michigan Road.

Soon after the road was established, the question of paving it was agitated and a petition was filed with the County Commissioners December 15th, 1913, asking for the paving of the section west of South Bend. At that time we had only the three mile road act under which roads could be constructed and as there was over three miles in two of the townships affected an election was called which resulted in a large majority favoring the construction of the road.

A contract for the improvement was awarded Sept. 14th, 1914.

Near the east town limits of New Carlisle this section of the Lincoln Highway crossed at grade the Chicago, South Bend and Northern Indiana Railway, the Chicago, Lake Shore and South Bend Railway and the New York Central Railroad in a distance of less than 600 ft.

The sharp angle made by the Lincoln Highway and the New York Central Railroad, the rather steep approach on the highway to the crossing and the high speed trains run over this section of the railroad, made this a very dangerous crossing. A number of disastrous accidents had occurred here resulting in the loss of life and property. Knowing that by paving this road and making it a part of a transcontinental route it would increase the traffic over it and thereby increase the hazard it was evident to every one that something should be done to eliminate the danger.

On May 22nd, 1916, the Board of County Commissioners of St. Joseph County passed a resolution relative to the needs of a grade separation at this place which would include all the railroads. A petition was filed with the State Public Service Commission asking for a hearing before that body on the question.

The hearing was held in South Bend and an order was issued by the Public Service Commission for the construction of a subway along the line of the Lincoln Highway under the tracks of the three railroads, this being the location desired by the St. Joseph County Commissioners. This order was issued July 8th, 1916, and work was to begin on or before January 1st, 1917.

Due to the excessive cost of constructing the subway along the line of the Lincoln Highway, the angle of the crossing being about 24 degrees, the railroad companies petitioned the State Public Service Commission for a modification of its order, permitting the construction of the subway at a point of about 343 ft. east of the point indicated in the first order and at an angle of about 52 degrees. Setting forth that this new location would mean a saving in construction costs of $65,760, the St. Joseph County Commissioners opposed this change and their opposition was sustained by the Public Service Commission.

The railroad companies then sued the Public Service Commission of Indiana to set aside, modify or amend its order in the St. Joseph County Circuit Court.

Thinking they would not get a fair trial in St. Joseph County, the railroad companies took a change of venue to the LaPorte Circuit Court, where the order of the Public Service Commission was sustained.

The Chicago, Lake Shore and South Bend Railway then appealed from the decision of the LaPorte Circuit Court to the State Supreme Court.

The State Supreme Court sustained the decision of the lower court and the Public Service Commission issued a supplemental order on April 30th, 1919, fixing a time when the work of the subway should begin.

The railroads applied for an injunction in the St. Joseph County Circuit Court restraining the Public Service Commission from enforcing their order.

While the case was pending, the State Highway Commission took over and made the Lincoln Highway a state road, thus

bringing to a close all litigations between the railroads and the county over the grade separation problems at New Carlisle for the time.

Nothing was done by the State Highway Commission towards the separation of grades and surveys were made for the purpose of changing the location of the highway and thus avoid the crossing entirely.

At about this time the people of New Carlisle becoming exasperated over the delay and the prospects of losing the state road passed an ordinance requiring all trains passing through their town to slow down to 12 miles per hour. This seemed to have the desired effect, for two of the railroad companies showed a willingness to open negotiations looking towards the separation of grades. The third, however, holding out because the State Highway Commission was not considered in the negotiations.

At about this time the State Highway Commission returned Lincoln Highway to the County, having decided to follow the new Division Street location. Through the influence of Mark L. Brummitt, one of the County Commissioners and a citizen of New Carlisle, negotiations were put under way looking towards the construction of a combination subway connecting the X Road, an improved county road running north and south and crossing the Lincoln Highway on Race Street in New Carlisle, and the Lincoln Highway in one subway, thus eliminating a dangerous crossing of the railroads on Race Street.

These negotiations finally culminated in the calling of a meeting in South Bend of legal and engineering representatives of all parties interested. This meeting was held in January, 1925, and resulted in the working out of an agreement satisfactory to all parties. A joint petition was then sent to the State Public Service Commission praying that the Commission's previous orders be vacated and rescinded and that a modified order be issued conforming to the agreement.

A hearing was soon afterwards held by the Public Service Commission in South Bend and the desired modified order issued.

An agreement between the five different parties interested was signed February 2nd, 1925, eight and one-half years after the first order was issued by the Public Service Commission.

The parties interested in this agreement are as follows, to-wit:

The New York Central Railroad Company.

The Chicago, Lake Shore and South Bend Railway Company.

The Chicago, South Bend and Northern Indiana Railway Company.

St. Joseph County.

The town of New Carlisle, Indiana.

Under the terms of this agreement the following items were specified, the separation of grades was to be accomplished by means of three separate subways under the tracks of each of the three railroads and at right angles to and at the point where the center line of the Lincoln Highway intersects the center line of the westbound main track of the New York Central Railroad.

The present grade of the N. Y. C. R. R. not to be changed. The grade of the C., L. S. & S. Bend Ry. to be raised about 8 ft., and the C., S. B. & N. I. Ry to be raised about 11 ft.

The Lincoln Highway to be diverted and a new segment of highway to be opened in a northwesterly direction from near the end of the old concrete pavement on Lincoln Highway. then changing to a southwesterly direction passing under the tracks of the three railroad companies, then turning to the right, finally connecting with the Old Lincoln Highway near Race Street in the town of New Carlisle. Also a segment of new highway connecting the first described segment with the X road. The highway approaches on each side of subways to have a grade of not more than 4%.

The highway depression of said subways to be drained by a 12 in. vitrified pipe sewer which was to empty into an existing 12 in. drain tile laid east from the subway on the south side of Lincoln Highway. This drain tile was laid to drain the proposed subway at the time the pavement on Lincoln Highway was constructed.

The new highway was to be paved not less than 18 ft. wide with suitable widened curves.

The overhead clearance to be at least 13 ft. for each of the three subways.

The horizontal clearance to be not less than 30 ft. nor more than 33 ft. between abutments.

The width of the pavement through the subways and the intervening property to be 30 ft. wide.

The subway structures for the interurban companies to be of the open floor girder type.

The structure for the N. Y. C. R. R. to be for four tracks and of the ballast floor steel girder type.

The grading on the right of way acquired between the interurban railways and the paving and drainage from the north right of way line of the N. Y. C. R. R. to be done by St. Joseph County, but paid for by the railroad companies. Each paying one-third of the total cost.

The subway structures to be completed before March 26th, 1926, and the pavement by July 1st, 1926.

The County Commissioners decided to do the counties' part of the work under a County Unit petition and a petition was immediately circulated.

The preparation of plans and specifications for the counties' part of the work was turned over to the County Engineer about the middle of February, 1925.

Preliminary Survey

In making the preliminary survey a center line of the Lincoln Highway was first established and the distance from the end of the old concrete pavement east of the proposed subway, to the center of X road was accurately chained. The intersection of this center line of Lincoln Highway and the center line of the westbound main track of the N. Y. C. R. R. was accurately located and its distance from the end of the old concrete pavement recorded. The angle at this point of intersection between the established center line of Lincoln Highway and the center line of the west bound main track of the N. Y. C. Ry. was carefully measured as well as the angle between Lincoln Highway and X Road. The tracks and right of way lines of the railroads were then located with reference to this center line. All this information was platted to a scale of 50 ft. to one inch and complete paper layout of the project made.

The estimated cost of the entire project was placed at $200,000. The expenditures of this large sum of money was to eliminate a so-called death trap and the idea uppermost in the engineer's mind was to construct the approaches to this crossing so that it would be safe to the traveling public for years to come. I believe that the engineer of today who is intrusted with the location and construction of public highways, if he functions rightly, must be ten years ahead of public opinion. He must have some vision of public demands of the future. If there is as much change in public opinion regarding highways in the next ten years as in the last ten years, many of the roads constructed today will either be reconstructed or abandoned, and new roads built, due to excessive grades and sharp curves. When this work was turned over to the engineer he was given to understand that his hands were free to make this an absolutely safe crossing but he had not proceeded very far until he found his hands decidedly tied. It is wonderful how much engineering talent is going to waste about small country towns. It may seem that the opinion of such citizens would have little weight, but I find that in county work it is a force to be reckoned with. The plans submitted by the N. Y. C. Ry. engineers and indirectly made a part of the agreement, did not seem to give much assurance of making this the crossing desired, so it was followed only in a general way.

At the north entrance to the subway where two lines of traffic would be coming in and going out, it was desired to construct curves of such radius as to give at least 300 ft. clear view. While some opposition was met with on this part of the project, there was nothing of serious nature.

The approach curves were established as 14 degree curves or curves with a radius of 410 ft. The intersection angles were made equal, thus making the approach curves symmetrical. The approach grades on this part of the work was made .80% instead of 4% as indicated in the agreement. The remainder of the alignment on the north side of the subway was worked out to in a measure conform to the approach curves.

In locating the approach curve at the south approach to the subway many obstacles were encountered. The subway is located at the foot of the hill upon which New Carlisle is located and the contours off the ground rises rather abruptly from the subway to a height of about 30 ft. above the pavement in the subway in a distance of approximately 400 ft. On the crest of this ridge or hill is located a group of old time farm buildings with a lawn and valuable shade trees in front of the residence, that extends down to the Lincoln Highway.

A trial alignment was run from near the entrance to the subway to a connection with the old Lincoln Highway near Race Street using two 20 degree curves

reversed with a short piece of tangent between. This alignment cut into this lawn and would make it necessary to remove some of the shade trees. The 100 ft. right of way would also be very close to the barn and other farm buildings. It was soon evident that this alignment could not be used due to the objections of the people of New Carlisle and the attitude of the Commissioners.

Then an alignment around these buildings coming into the Lincoln Highway in New Carlisle from the south was considered but this was abandoned because it would have required two right angle turns in the town of New Carlisle.

A second alignment was then run by compounding the 20 degree curve at a point 300 ft. from the south entrance of the subway to a 23 degree curve and then with a short piece of tangent between reversing to a 23 degree curve and finally connecting with the old Lincoln Highway east of Race Street. This alignment was finally used in the construction of this approach.

Practically all the new right of way required for this project was owned by one party and as it often happens the value of the land went up very rapidly. The damage was placed by the owner at $25.000. The necessary property was condemned by the Commissioners and the appraisers awarded him $3,250. The landowner then appealed to the Circuit Court to test the utility of the project.

All this was holding up the ultimate completion of the work and the people of New Carlisle were becoming very impatient. Finally the landowner suggested that he would take the award if the south approach was moved 50 ft. farther from his barn. This, the Engineer objected strenuously to and suggested as a compromise that a retaining wall be constructed along the south side of this approach with the face of the wall 21 ft. from the located center line of the approach and that the face of the wall be made the south right of way line. This proposal was agreed to by the landowner and Commissioners.

Adequate drainage for the subway required considerable thought. As has been said before, the subway is located at the foot of a hill. To the east and north lays Terre Coupee prairie, a very flat, level country. Levels were run north along the X Road and east along Lincoln Highway. About one mile east of the subway on the south side of Lincoln Highway is an open drainage ditch, a tributary to the Kankakee River. It was found that by keeping the drainage pipe under the pavement in the subway as high as possible a fall of 0.125% in 100 ft. could be obtained, so this was the outlet used.

The runoff from the pavement on Lincoln Highway in New Carlisle and a good portion of the town itself flows along the gutters of the Lincoln Highway and did previous to the construction of the subway follow an open ditch along the south side of the New York Central Railroad.

Due to the sandy nature of the soil in the approach cut at the south entrance to the subway and the possibility of washing, it was decided that it would be best to prevent any water from running into this cut.

The runoff from New Carlisle was carried along each side of Lincoln Highway as formerly, using an 18 in. reinforced concrete pipe culvert with concrete intake headwalls with a grade, to carry the water on the south side under the new pavement. At a point about 200 ft. from the subway, the water from the north side of Lincoln Highway is brought across the old highway through an 18 in. pipe culvert. At this point the water from both sides empty into a concrete catch basin and from there the water passes through another concrete intake headwall with a grate into an 18 in. reinforced concrete pipe which carries it to a concrete manhole under the pavement near the south end of the subway, a drop of over 13 ft. The water passes from this manhole through an 18 in. reinforced concrete pipe under the center of the pavement to a second manhole under the pavement near the north end of the subway. From this point the drain passed out from under the pavement and followed along the south side of the new and old highway to the open ditch outlet, using 18 in. vitrified sewer tile with cemented joints, 4 by 4 ft., concrete manholes with standard covers were placed at all angles and at intervals of about 500 ft. on straightaways.

Intake basins with standard grates were placed in the gutter line on each side of the manholes in the subway. These were connected with the manholes with 12 in. reinforced concrete pipe.

Provisions were made for taking care of the runoff from the hill back of the retaining wall by installing a 10 in. farm tile just back and 4 ft. below the top of the wall with three concrete intakes.

This drain pipe was connected with the manhole at the south end of the subway. Along the house lawn at the west end, a concrete gutter was used. The water from this gutter was carried into the main drainage system.

There was 27,000 cu. yds. of excavation in the project, most of which was waste. After a vain attempt to reach an agreement with the two interurban railway companies looking towards putting it in their approach fills or obtaining permission to waste it on the New York Central right of way, it was finally turned over to the contractor who would get the job, to worry about. He was able to effect an agreement with the interurban companies and the waste was used in making their approach fills.

The pavement is a uniform 8 in. concrete slab, 20 ft. wide on tangents and the 3 deg. curve with 2 in. crown. On curves over 3 deg. the pavement is widened from 20 ft. at the ends to 28 ft. at the center, and superelevated. On tangents and the 3 deg. curve, the pavement was finished with a finishing machine and on curves over 3 deg. the entire width of the pavement was laid at one time, struck off with a heavy straight edge and finished by hand.

A 16 gauge 7½ in. corrugated metal strip with ½ in. round deformed tie bars were placed in the pavement on the center line, and ¾ in. round deformed bars placed in the center of the pavement 6 in. from each edge, were used throughout the entire job.

A 1 in. preformed expansion joint was used every 100 ft. with ½ in. round deformed bars placed transversely in the center of the pavement on each side and 4 in. from the joint.

The curve intersections were laid one-half at a time, the two halves being tied together with ½ in. round deformed bars.

The retaining wall is 680 ft. long and ranges from 6 to 15 ft. high. It is of reinforced concrete of the cantilever type design constructed in 50 ft. sections.

The contract for the counties' part of this work was awarded to the Highways Improvement Company at a lump sum price of $69,860.79.

The contractor at all times showed a desire to use the best materials and to do first class work, and I believe as far as material and workmanship is concerned it is as good a piece of construction work as can be found any place.

SOME COUNTY DRAINAGE PROBLEMS

By H. C. Morrison, Gibson County Surveyor, Princeton, Ind.

(Paper delivered at Thirteenth Annual Road School, Purdue University, January 17-21, 1927.)

The subject of County Drainage Problems is a broad one and includes a great many phases. In order that I may bring out some of these points, I have decided to discuss some of the problems and difficulties arising from the work in the design, preparation and construction of a particular drainage system on which I am now engaged.

This drainage system is known as the Wm. Metz et al., or Big Creek, located in Vanderburg, Gibson and Posey Counties, Indiana. It consists of a system of one main ditch 30 miles long, and some 30 laterals varying from a few hundred feet in length to 9 miles, making in all main and laterals about 60 miles. In addition, there are a number of miles of natural ditches, but this is the extent of our improvement.

The drainage area comprises about 260 square miles or 166,400 acres, extending from State and Federal Road Number 41 on the east to the Wabash River on the west and covering a territory north and south on an average of 6 or 7 miles.

This work consisted in the reconstruction of the main ditch and one of the main laterals. These we cross sectioned. Our first work in the preparation of the report consisted in the preparation and drafting of a map. We were confronted with the enormous task of verifying the descriptions of the lands contained in the petition, which in the first place only contained perhaps a third of all those assessed. This petition for the reconstruction was begun before the recent law came into effect requiring two-thirds of the land owners affected to be named in the petition. The records were located at three county seats and this made the work a bit more tedious as I have found that different counties have systems of their own in keeping their records. This map contained the lands, civil and congressional township lines, county lines, present location of ditches, railroads, roads, etc., without any contour lines. We are fortunate in having in this section of the State Geological Maps, showing all contours of the surface at 20 ft. intervals.

After the map was prepared we began

our surveys and field work. This did not include very much location work on the main ditch, as the same had been dredged about 15 years ago and new location meant in a good many instances three ditches, the old natural water course, the old dredged ditch and any new location that might be made. Since in many places the valley is narrow, I did not think it advisable to make new location, except in one or two instances. The old dredge ditch had a fairly good alignment.

You note I used the word advisable. Sometimes in order to keep peace among the land owners, we engineers have to forego good location practice for policy's sake and make up for the poor location by better design.

Our first surveying consisted of running a line of levels along the edge of the ditch. This proved to be a very long and tedious job. You are all familiar with dredge ditches and know just about what kind of growth to expect where no attempt has been made for fifteen years in the maintenance. Now right here is the place to call on some of Purdue's material. This is a good place to hire some of the boys who have had their training in civil camp and give them a real taste of engineer's life, cutting briars, fighting mosquitoes, chaining, rodding, etc. Well, that is just what I did—I called on two of the boys and started them off right. They made good and have since been promoted to better jobs. After or coincident with our line of levels we cross-sectioned the work at each station. We endeavored to adopt some easy way of cross sectioning, by use of tapes, plum bobs, gages, etc., but were unable to find anything better than tape, rod and hand level—picking up our elevations previously run at station stakes.

On the laterals we had our location lines to run with transit but for the most part no serious problems were encountered.

By the time we got our cross sections completed we had become pretty familiar with the various drainage basins, water sheds, nature of soil as to texture, both throughout the whole water shed and along the route of the ditches. This familiarity enabled us to better determine what we might reasonably expect in the way of run-off, and what slope of banks would be necessary.

In determining the run-off, I made a thorough investigation at three weather bureau stations, as to the duration of the various storm periods and made a record of all rainfalls of more than 1 in. in 24 hours. At Evansville, which is not in the district, but is not far from the boundary of the watershed, I found very complete records. With this data at hand, and with other data concerning run-off, I decided to design the main ditch for a little more than 1 in. run-off in 24 hours for the upper stretches of the ditch which was fed by streams from the steeper part of the watershed and a ½-in. run-off for the lower stretches of the ditch.

The amount of the run-off to be provided in farm drainage varies considerably, depending upon the degree of improvement, and the damage that would result from overflow. Farm drainage is seldom complete enough to prevent all overflow as the cost would be prohibitive and short periods of overflow on farm lands are not serious during the time of year when the heaviest rainfall usually occurs. If a drainage system is well balanced, any overflow occurring after unusually heavy rains will be well distributed and of short duration.

After platting our elevations, profiles were made. In determining the grade of the main ditch, I found that an economical grade could be made with just one break. The upper part of the ditch from station 0 to 943 or about 18 miles with a grade of 3.06 ft. per mile and the remainder with a fall of 1.37 ft. per mile.

The next step in the design consisted in determining the areas to be taken care of, up to the various points of confluence of the several laterals. For instance, the area above station 0 plus 00 of the main ditch is 37.6 sq. miles. With the run-off as previously decided upon of 1 in. in 24 hours, which is equivalent to 26.88 cu. ft. per second per square mile, I found that the ditch should take care of 37.6 times 26.88 cu. ft. or 1010 cu. ft. per sec. I decided on making a 12 ft. base.

The reasons for using a 12 ft. base were, that above station 0 an old ditch had been constructed some years ago which emptied at our station 0 with a 12 ft. base and also that we could get the full benefit of the old excavations by using a 12 ft. base.

With a section of 12 ft. base, depth 15 ft. and slope of banks 1:1, I next determined what velocity to expect in the new ditch. This was calculated from the old reliable Chezy Formula. We also

used Kutter's Formula for calculating the value of C in the Chezy Formula.

With a cross sectional area of 405 sq. ft. and a velocity of 5.52 ft. per sec., you will readily see that a run-off of more than 2,000 cu. ft. would be taken care of when the ditch is running full. If we assume that a ditch running 4/5 full is a proper one to design we still have an excess capacity, but in view of the fact that just a short distance below station 0 some 20 sq. miles more drainage area is added by laterals and in order to have a base width conforming to the ditch above station 0, and still further to take care of some silting that may occur in the upper part of the ditch caused from deposits being washed from above our improvement, I deem it advisable to construct the ditch with this factor of safety.

By this same process, I further proceed to design the entire system.

At present the work is about one-third completed and it is gratifying to note on those completed sections how nearly the calculated velocities approach the actual velocities which obtain. I have already had occasion to test out a few of them.

One of the first difficulties which we encountered was the presence of rock on the main ditch at about station 264. This we found where we had not expected. In our preliminary work we made a number of borings to determine the location of rock, but at this place we had not tested. This stone proved to extend for a distance of about 150 ft., and from 1 to 3½ ft. above grade. After the rock was discovered, the contractor attempted to blast the stone by making some depth charges, but this failed to loosen it, so we allowed the contractor to go on with the floating dredge and will remove the stone after the ditch runs dry or nearly so during the dry season, by drilling, blasting and removing stone by the use of a drag line which the contractor has near that location.

One other difficulty which we encountered was as follows: A 2¼ yd. drag line machine was assembled on the west side of State Road No. 65, which leads from New Harmony to Mt. Vernon in Posey County. This boat dug down stream about 2,000 ft. on the north or right side of the stream and then crossed to the left side and proceeded up stream to said State Road. Here we stopped. We stopped because we were confronted by a federal injunction issued to prevent the crossing of the road. Here the boat remained for a considerable time but after some delay some attorney for the contractor got permission to jump the road and begin excavating some 100 ft. above the road. The work has continued up stream some four miles to where said drag line machine again crossed to the right side of the ditch and is now again digging toward the State Road. We are unable at this time to say just what the outcome of the affair will be, as there seems to be no law by which a dredge ditch can cross a federal road.

Fortunately we have the old channel of the stream which forms a diversion, leaving the dredged channel some 3,000 ft. above the state road and again having its confluence with the same some 2,000 ft. below the road, and crossing the state road some 3,000 ft. north of the dredged channel. We had planned to close this at the upper end by means of the construction of a substantial levee across said old channel thus causing all of the water to flow through the new channel. With the removal of this levee we will be able to obtain the necessary capacity for the drainage areas above and thus be relieved of the embarrassing situation of crossing and excavating across the state highway the full specified width.

The total amount of the excavation of the drainage system is 2,084,000 cu. yds. and the contract price is $196,000. The work is being done by the Walb Construction Company of LaGrange, Ind., with Mulgrew & Sons Company, of Dubuque, Iowa, sub-contracting about 672,000 cu. yds. of the main ditch. The base width of the main ditch varies from 12 ft. at the beginning to 54 ft. at the outlet, with top widths varying from 35 ft. to 110 ft.

GRAVEL ROAD MAINTENANCE IN MICHIGAN

By J. T. Sharpensteen, Maintenance Supervisor, Michigan State Highway Department, Lansing, Michigan.

(Paper read at 1927 Highway Conference at University of Michigan.)

Successful gravel road maintenance is dependent on many factors, among which four at least may be considered as fundamental; namely, funds available, organization, methods and equipment. For the purpose of this discussion two will be considered—methods and equipment.

To be entirely successful, gravel roads must be smooth at all times, dustless in dry weather, free from water in

rainy weather, and of such width, shape and condition that the possibility of accidents will be reduced to a minimum.

With climatic conditions peculiar to Michigan, it is unlikely that 100 per cent efficiency will ever be possible throughout the entire year; however, in resort sections where maximum traffic is handled during the summer months, it is quite possible to secure satisfactory maintenance practically all the time.

The conclusions which will follow are based largely on the experience of maintaining more than six hundred miles of state trunk line gravel roads in thirteen counties located in the northwestern part of the lower peninsula. It is not assumed that all the ways and means found effective on these roads may be applied with the same results in every locality, although it is believed that many of the methods used are applicable to gravel road maintenance in general.

To fully appreciate the reasons for doing a number of things that have been done, it is desirable to understand the character of the roads being discussed. A large percentage of the mileage was improved as state reward roads with grades ranging in width from sixteen to twenty-four feet and gravel surfaces varying from nine to sixteen feet in width. The narrow widths predominated and bank run gravel was used extensively in construction. A portion of the mileage was improved under state trunk line specifications but consists very largely of one-course construction. The balance of the mileage which appears to have been improved has been built up under maintenance by adding a small amount of gravel each year. A light, sandy soil is common to practically the entire territory. Gravel secured from local deposits, which is the main source of supply, has a sand filler and cannot be compacted so that it will withstand traffic and varying degrees of moisture.

On account of the gravel having a sand filler and the light sandy soil of which the roadbed was constructed, it was inevitable that the one would become mixed with the other, further reducing the possibility of maintaining a consolidated metal surface. To reduce the loss from loose gravel being thrown into the ditch, high shoulders were built and maintained. With loose gravel in dry weather there was some justification for high shoulders for retaining purposes, but in rainy weather the roads presented a canal-like appearance until the water had had time to soak into the roadbed except in hilly sections water flowed down the inside line of the shoulders to low points causing serious washouts. Under these conditions travel by automobile was slow, tiresome and expensive. Accidents were frequent and the loose gravel furnished a perfect "alibi" for every accident regardless of the cause.

In order to keep the investment in equipment as low as possible, it is necessary to secure equipment that can be used the year around. It is evident that certain equipment used in winter cannot be used in the summer. On the other hand, a major portion of the summer equipment, such as trucks and heavy tractors, can be used in snow removal work. There are special gravel road maintenance units that give satisfactory results when used for the purpose for which they are designed but for snow removal in this locality are of little or no use.

Beginning with the spring break-up snow and ice are removed from the road as rapidly as possible. On roads which have been kept open for wheel traffic the ice covering disappears with the first few warms days of spring. On those roads not maintained for wheel traffic during the winter a much longer time is required to clear away the snow and ice. On such roads, at points where there has been little or no drifting, the snow covering disappears in a short time inviting automobile traffic to start using the road. By this time the drifts have settled down making it possible to drive on top of them, resulting in the formation of ruts which soon wear down to the gravel surface. These ruts are filled with water and, with the concentration of traffic in them, soon extend deep into the gravel surface and, in many cases, into the subgrade often rendering sections of the road impassible while the frost is leaving the ground. When the ice and snow have melted sufficiently to permit floating, the ruts have reached such depths that scarifying is really the only effective and sure way of removing them. On roads where snow removal is undertaken, floating can be started much earlier and the formation of ruts prevented. Snow removal is therefore an aid to summer maintenance and the added cost

of putting a road, from which the snow has not been removed, in a satisfactory condition would go a long way toward keeping it open throughout the winter.

For the purpose of early spring cutting a ten-ton tractor and a heavy grader are used. High shoulders are cut down so that water falling on the road may reach the side ditches without delay. The crown of the road is reduced to about one-quarter inch to a foot width of road. The metal surface is spread out to a width of twenty feet if possible. The outer edge of the widened metal surface is often quite thin but has been found of sufficient strength to give fairly satisfactory service in dry weather.

Floating with what might be called light equipment is started at the same time heavy cutting is begun. Trucks of three or three and one-half tons capacity equipped with spring blade scraper attachments are used for the greater portion of this class of work. Tractor graders have been used with good results but, on account of trucks answering the requirements of winter work very satisfactorily and, due to the fact that a greater number of trucks are required for snow removal than for floating, it is economical and satisfactory to do this class of work with trucks. By using trucks throughout the year the investment is soon covered by accrued rentals. With the rental rates that have been used for some time the initial cost of a truck can be paid for in fifteen months. Both ten and twelve-foot spring blade attachments have been used and it was found that the twelve-foot length could be handled satisfactorily by a three-ton truck and, in most cases, the entire width of gravel surface covered with one round trip. These attachments have been used in snow removal with very gratifying results. Light snows can be handled by this means alone and on trucks equipped with "V" plows the attachment can be used for cleaning at the same time heavy snow is removed by the "V" plow.

An effort was made during the past year to eliminate loose gravel. This was accomplished in a few instances by depositing it on the shoulders to remain there until late in the season. As a temporary expedient, this method was effective but has the same disadvantage as high shoulders and was used only as the last resort. The most satisfactory results were obtained from adding sufficient binder to consolidate all, or nearly all, of the loose material. Clay being the only local material having the desired binding qualities, it was used extensively. The application of binder was carried on by thirteen different organizations and, as might be expected, uniform results were not always obtained; however, with the exception of a few isolated cases, all loose material in the gravel surface was consolidated, ending a dangerous condition of long standing. Definite instructions for applying clay cannot be given on account of clay in the different deposits not having the same characteristics and on account of no two miles of the same road requiring the same treatment. The success of the application depends very largely on the judgment of the man in immediate charge of the work. From one-half to two yards per one hundred feet of road is the amount of ordinarily used. It should be spread uniformly over the entire gravel surface and mixed with the loose material by harrowing or frequent floating. Following the first rain, intensive floating with both heavy and light equipment should be done until the surface has dried sufficiently to prevent its being cut up by heavy loaded vehicles.

A notable example of the results obtained by using clay is a seven-mile section on Trunk Line 13 located between Cadillac and Manton. In former years during dry weather the surface of this road would become loosened to such an extent that the slag base would become mixed with the gravel in the surface course. Early last spring clay was applied at the rate of one cubic yard to a hundred feet of road. Following the first rain the results were very unsatisfactory, but by floating constantly during the drying-up period, a smooth, uniformly shaped surface was obtained. After a few days exposure to the sun it was discovered that no material had been left for floating and the surface could not be cut with floating equipment. Immediately following succeeding rains a slight amount of material could be moved with a grader but, after it had dried up, floating was discontinued until the next rain. In the latter part of June calcium chloride was applied and following this the surface seemed to get even harder. Holes appeared occasionally on sharp curves, but these breaks were repaired by filling with clay and gravel to which a small amount of calcium chloride was added. The cost of

patching for the entire season amounted to $75.00. The opinion was often expressed that this road could not be properly maintained in wet weather but it was a surprising fact that less trouble was experienced in rainy weather than on other roads that had not been similarly treated.

There has been a practice of doing as much resurfacing each year as funds would permit. This work was usually performed in the summer when traffic is heavier than at other seasons of the year and increased, instead of abated, the loose gravel menace. Light resurfacing, if done in the early spring or late in the fall, improves the road but it is believed that the same amount of money used in a different way will result in more satisfactory maintenance.

By stocking gravel at convenient points along the road and using it at places where there is an obvious need for additional gravel, a considerable saving can be made over a general resurfacing. All maintenance organizations are instructed to emphasize patching in rainy weather to the exclusion of all other work except possibly floating. All available trucks are loaded from stock piles and the gravel is placed wherever water is standing on the road. Roads dry up very quickly in the summer and, for this reason, it is imperative that the work of filling holes and low places be pushed as rapidly as possible. Frequently this work is performed while it is raining and, whenever possible, is done in advance of floating. Not all the necessary patching can be done in wet weather but, by doing as much as possible with each rain, the need for patching at other times is not of serious consequence.

The use of a dust layer has been a very important factor in improving the condition of gravel roads. For this purpose calcium chloride only has been used On account of the lack of information, the relative merits of the other dust layers will not be discussed. The application of calcium chloride is worthy of serious consideration. June 15 is the approximate date for making the first application, in this section. A short time before making the first application, a heavy grader is used to reshape the road and, immediately preceding the application, all loose pebbles are scraped off and deposited on the shoulders to remain there during the life of the chloride. The first application is made at the rate of four or five tons to the mile, depending on the width of the metal surface. A distributor equipped with screens, baffle boards and having an agitator similar to a lime drill is used, and, although it may be considered of small importance, rubber tires on the wheels of the distributor make a substantial difference in the results obtained. Every effort is made to secure a uniform distribution which is very nearly impossible with steel tires. The distributor is attached to a heavy truck that is capable of maintaining a uniform rate of speed on rolling grades. A stake body is best for the truck to which the distributor is attached. One-ton trucks are used to haul from the car or storage and, by having a stake body on the heavy truck, the transfer of sacks from one to the other can be made rapidly. The practice of changing the distributor from one truck to another is discouraged. No floating is done until the chloride is completely dissolved, which is usually the next day following the application. The cost of applying chloride in this way costs, on an average, about one dollar and sixty cents a ton with a low figure of one dollar and twenty-three cents a ton in one county. The cost, of course, depends on the length of haul. The same methods are used in making subsequent applications as in making the first. In case eight tons to the mile are specified, the second application of three tons is made just before Labor Day. It has been found that the length of time which chloride lasts can be increased very materially by the use of clay as a binder.

To secure an absolutely uniform distribution of traffic over the entire width of the metal surface is probably impossible, but the basic idea kept in mind at all times is to approach this condition as near as possible. The attainment of this end involves a low crown and a surface in such condition that the driver of a motor vehicle cannot, consciously or unconsciously, follow in the tracks of vehicles that have preceded him.

An operator of a motor vehicle experiences difficulty in driving over a loose gravel road that has just been floated. Succeeding drivers find less difficulty because they followed in the tracks already made by preceding vehicles. This means a high concentration of traffic on from ten to fifteen per cent of the metal width. The degree of concentration varies directly with the depth of loose material present.

An estimate of the wear of gravel must take into consideration the amount of loose cover used for maintenance. It is self-evident that the loss from the erosive action of wind and rain, the abrasive and throwing action of traffic, the air currents created by rapidly moving vehicles, varies directly with the quantity of loose material acted upon by these forces. Therefore, in order to reduce wear to a minimum, it is necessary to reduce cover material accordingly.

The final test for gravel road maintenance is the class of service furnished the traveling public. The amount of money required to furnish good maintenance depends on the class and quantity of traffic accommodated. With modest allowances every effort has been made to economize and yet, at the same time, there has been a constant public demand for the better maintenance. To get by, so to speak, the employment of methods, that in some instances conflict with well-established usage, has been made necessary. Improvement is often the result of abandoning ideas that have served useful purposes and it is believed that the ultimate solution for gravel road maintenance will be found in keeping the surface in such condition that floating or scraping can be dispensed with except in wet weather.

USE OF CALCIUM CHLORIDE IN GRAVEL ROAD MAINTENANCE

By Allan M. Williams, Road Engineer, Ionia County, Michigan.

(Paper read at 1927 Highway Conference at University of Michigan.)

Calcium chloride in the maintenance of gravel roads keys in with all the operations so well that it is difficult not to cover too much territory in explaining the use and benefits derived.

As mechanical means have not been developed which will produce the desired dampness in a gravel road surface, the function of calcium chloride in the maintenance of gravel roads is due to its ability to take out of the atmosphere about three times its own weight of water. This moisture adheres to the dust particles and prevents their otherwise being blown away.

Possibly those who are not familiar with calcium chloride may be interested in the manner in which it is applied and the preparation of the road necessary beforehand. As soon as the frost leaves the ground in the spring we endeavor to get the road patched, that is, all depressions filled and a loose floating mat provided the entire length of the road. This is usually accomplished before the Spring rains cease and the roads become dusty.

An application of chloride is then in order so that as much as possible of the fine material or binder is saved from blowing away. Just prior to the application of chloride, however, the road is floated and put in shape to receive it. The chloride is allowed to dissolve and penetrate the road surface before being scraped again, which is usually the next or second day after the application.

The chloride is loaded on trucks either from storage or directly from the car and carried out to the road which has been prepared to receive it. An ordinary lime drill is then hooked to the rear of the truck and the chloride dumped from the sacks directly into it. The truck is started ahead as the ports are opened in the lime drill. The truck drives at a rate of from four to six miles per hour until the load is exhausted. It is very important that the distribution be as even as possible; however, some conditions may require more and some less.

The drill is either then switched to another truck and the process continued, or the original truck is reloaded from feeder trucks. The former method is more economical as it saves one handling of the chloride. The second method may be found more convenient in some instances. The driver of the spreading truck should drive at a consistent rate of speed parallel to and a little to the right of the right hand traffic lane so that if any gap is left it will be in the center which will gradually become treated due to the floating action of the road scraper.

An eight foot lime drill is used and two widths are usually sufficient to treat a twenty-four foot gravel road.

There is a difference of opinion among engineers as to the proper amount of chloride to be applied and the treatment will vary from two and one-half to five tons per mile. The State Highway Department's estimate of $30.00 per ton is very close to the actual cost; however, there may be a small variation one way or the other. The shipping of chloride in 100 pound sacks is a very convenient way to handle it and provides a means of checking the distribution.

The fine particles are as essential to the bond of a gravel surface as the gravel that makes up the coarser aggregate. A light loose mat of fine material is indispensable as a protection to the bonded part, as it takes up the slippage and skidding of the wheels of traffic. This naturally produces wear which reduces the size of the material and powders some into a dust. Besides being a deterioration of the road, it becomes a menace to comfort and safety as well. The fact that gravel will not bond until sufficient fine or cementing material is either added or produced from wear proves this need. When scarifying, the hardest roads to break disclose that the grading of material must be from the very finest to the maximum size stone allowable, and enough fine material to completely fill the voids.

In discussing this subject, the retaining of the fine aggregate in its place is that with which we are particularly concerned. The loss of the fine material due to being blown away varies in an inverse proportion to the amount of moisture in the surface within a certain limit. The loss by wind, however, is always great enough so that a surplus does not collect and become bothersome. The dust is the cement, and in adding new material the percentage of cement must be large enough to replace that which is lost and is best added in the form of limestone or clay. This also adds to the effect of the chloride where chloride is used.

As the action of traffic and the elements is to start the ravelling of the road surface by releasing the finest of the fine material first, it is important to employ some agent which will prevent the dust from being carried away where the volume of traffic is such as to warrant its use.

Let us consider the destructive elements which tend to dislodge the particles that make up the surface of a gravel road; namely:

1. Traffic: a. Abrasion; b. Skidding; c. Vacuum created by tires; d. Air currents created by the vehicles.
2. Water: a. Rain or melting snow; b. Longitudinal flow on road surface; c. Splashing of mud.

The first is no doubt equal to the second and in our endeavor to control the first the second must be employed to a limited degree. The flow of water longitudinally on the road surface can be opposed by maintaining the proper cross-section, thereby overcoming the collection of water and its force.

In order to overcome the action of traffic as far as possible some agent must be employed to reinforce the natural bond or to supplant it with an artificial one. Calcium chloride is a reinforcement and has the advantage of not destroying the natural bond when its effectiveness is apparantly worn out. The tendency of the chloride is to penetrate the surface of the gravel and to crystallize; this strengthens the crust and the dustless feature can be quickly revived by another application. The simplicity with which calcium chloride can be applied is a decided advantage. The effectiveness of the chloride is enhanced by the use of a percentage of clay or limestone in the resurfacing material which should be uniformly mixed to obtain the best results.

In making a gravel patch if a small percentage of chloride is mixed with the gravel, the patch will stay put where otherwise dry material would be forced out by traffic and the hole still remain. Another method of patching is to first put the chloride into solution and then spray over the patch after it is made, being careful not to add so much of the solution as to produce a mortar.

All road men know the advantages of a rain in aiding the action of maintenance machinery, likewise the same benefits hold true where chloride is used. Naturally the moisture is greatest in the early morning and the early morning floating should not be disregarded on this account as the machine's effectiveness is greatly increased and is therefore more permanent.

Because of the dust or binder being held on the road, repeated resurfacing is greatly reduced. The road must be watched, however, as the floating mat will become compacted in places and a crust will be formed, in which case fine gravel must be provided in a light layer as soon as possible. A conservative estimate would be that from forty to fifty per cent less resurfacing is required where chloride is used.

An application of chloride is always greeted by the motorist with a spirit of welcome as he is aware that it effects no damage to his tires or car and he drives on thinking that the joy of a dustless road is the only benefit derived. The dustless feature is fundamentally the source from which all benefits are derived, but the assistance to the main-

tenance organization in giving the public what it demands is equal to the comfort derived by the motorist.

Regardless of how much effort is spent toward keeping a heavy traffic gravel road in the best of condition, that effort would not be apparent in a very short time were it not for the employment of some agent to assist in keeping it so after the road machines have done their part. It would be economically and physically impossible to fulfill the demands of the public as well as we have were it not for the use of chloride. The public is becoming more exacting year after year in respect to roads and I believe that competition between the maintenance units should be fostered and encouraged. Miles of smooth riding are required to cause a tourist to forget the impression of the last hard bump and it behooves the organization to keep the entire system at its best.

A cloud of dust created by a car is a source of danger not only in obscuring the vision of the passing car but to the health of the occupant of the car behind and to farm people living along the road. The dust penetrates the houses and settles on everything in them, causing serious inconvenience and discomfort not only among people but to live stock as well. Vegetation is impaired for a distance from the highway and natural beauties are obscured. The use of chloride effects a permanent and economical remedy for the evils of the dust nuisance without creating another, as some other dust layers are apt to do.

In closing, some uses of chloride in winter maintenance might be mentioned. Although it may not be economical to remove a thick layer of ice for any distance, short patches can be removed where danger exists in a very short time. Also its use in removing ice from catch basins and culverts is very convenient. Where a winter haul of gravel is being made a strong solution of chloride for painting the gravel boxes prevents the gravel from freezing and sticking.

Calcium chloride, therefore, has its place in winter as well as summer and provides a means for making the best of the situation. The roads where chloride is used are usually those which carry a volume of traffic which would warrant a higher type surface as soon as such can be financed.

PERFORMANCE OF HIGHWAY CONTRACTS

By M. De Glopper, Asistant Construction Engineer, Michigan State Highway Department, Lansing, Michigan.

(Paper read at 1927 Highway Conference at University of Michigan.)

The subject of Contracts and Contract Performance, including their preparation in such a manner that the subsequent accomplishment of the requirements may be realized with mutual satisfaction, is one primarily dealing with the rights of man among his fellowmen. To assume contract liabilities it is required that the several parties shall observe certain formalities and that these formalities and their intentions be made a matter of record in order that interpretation may later be resorted to upon the basis of fact. That we may better understand the importance of the essential details of highway contracts it is advisable, in fact quite necessary, for us to acquire a general knowledge of the common business rights of man in order that our respective obligations and benefits may be defined and safeguarded.

The comparative absence of disputes in the courts in connection with the performance of highway contracts is a sufficient and gratifying testimonial to the high standard of our present contract practice as well as indicating the proper relationship of mutual understanding between the contracting parties which has resulted from the efforts of co-operation and a willingness to exercise fair dealing between men in the performance of their work. This satisfactory condition has come about through the increasing tendency of each party to look at the several parts of a contract through the eyes of his co-contractor as well as through his own and this desirable action has materially resulted in eliminating the mist of misunderstanding which enveloped early contract operations. It is now generally understood that no rights can exist without a corresponding obligation and duty and with this knowledge comes a realization that somewhere along the line each person must pay for what he receives. In other words, the law dictates the principle that no man can expect something for nothing.

The entire subject of contracts and specifications is one of comparative simplicity providing the mind is kept open to honest consideration and the desire for understanding. The confusion that

prevails to some extent through the belief that a man's rights are delegated by and through the law in a manner and measure different from that practiced in our every day business and social intercourse should be dispelled from the mind seeking enlightenment. This confusion is the result, perhaps, of the necessary intrenchment behind legal terms in order to maintain regularity and prevent contradiction in meaning. A genuine understanding of the terms of the contract will, however, dispel all fear of the law and the legal phraseology commonly used may then be interpreted into the common sense of every day usage. We cannot nor need not, transpose the mind of the lawyer to that of the engineer, neither should we ever attempt to divorce the assistance of legal counsel. In the final analysis, however, we find that real intent and mutuality are the dominating influences behind a valid contract and these conditions can only be met by a realization and admission that every man has certain inherent rights in every day life and bargaining which must be respected through the application of the principles of common sense. In the absence of these principles and influences in the minds of the contracting parties no lawyer could or would attempt to establish or reduce to writing a statement or contractual conditions worthy of the name of a contract.

In substance, the contract itself consists of three parts. The covenant, or legal part, which is usually prepared by legal counsel, covers a statement of the facts that for a certain consideration a certain piece of work will be performed in accordance with the rules set forth for such performance. The second part, covering the specifications, is a detailed explanation of the general governing provisions, the purpose of which is to denote what is desired on the part of the owner, how the work is to be controlled and what the relations of the parties shall be toward each other and toward the public. The third part, supplementary to the specifications, is the detailed plan of the work to be performed in which the requirements of work items is presumed to be as complete as is possible from all the possible source of available information.

By definition the contract is an agreement of mutual understanding entered into between two or more competent parties covering the full acceptance of a legal offer for a proper consideration. This implies the satisfaction of the four essential features which must be found in every contract, namely, (1) Competency of the parties, (2) Legality of the subject matter referring to the nature of the work to be performed, (3) Proper consideration in return for the performance of the work, and (4) Mutuality of understanding and intention. The first two conditions or essentials, competency and legal subject matter, need no further explanation as these matters are of common knowledge in the particular work in which we are interested. Likewise, the condition of consideration is one in which there is little or no disparity in as much as the amount of money to be paid for the work is a point of common understanding and is based upon the willing and full acceptance of the offer under consideration. The perfection of this essential does, however, demand the exercising of completeness in the statement of conditions which it is anticipated will be encountered and require that no information be withheld which is known to the one party and should be made available to the other. With this condition satisfied it is only necessary for us to know that the consideration agreed upon is a proper one and the question of adequacy is one only for local determination in connection with public policy providing of course that it comes within the bounds of reason and is reasonably equivalent to or commensurate with the obligation assumed. The only question which might arise as to the third essential is in its relation to the fourth and most important requirement, namely, the mutuality and intention of the contracting parties. This implies the necessity of a genuine agreement or the concurring of the minds in the same opinion, purpose or understanding. Here we face the fundamental and basic principle of contract law. The other conditions refer to people or material factors but in mutuality we are concerned with the mind of man and the analysis is more difficult. It is impossible to enter into a person's thoughts to ascertain what he is thinking of or how fully he comprehends what he is doing or what he intends to do. Direct proof being therefore impossible, how can we approach the fulfillment of this condition? How can we answer the question as to whether there was a proper relationship of mutuality, a real meeting of the minds? The only possible way to meet this condition, it

seems, is through and by careful and honest preparation of the contract in all its parts. If the interested parties were able to place the proper reliance in each other as to integrity, understanding and intention, with a feeling that the agreement could be carried out without violation, there would be less necessity for a knowledge of the legal requirements and perhaps the expressed contract could be dispensed with entirely. But the magnitude of the conditions affecting the performance became more complex because of the commercial nature of our work and for that reason the need of a written record of our desires and intentions becomes necessary in order that the assent of both parties may be definite, unconditional and unqualified.

The purpose then of the contract, and more particularly the section covering the specifications, is to provide a means of recording what the intention was or reasonably should have been at the time the contract was made and signed. The rights of the parties are thus established not alone as a declaration of the understanding and intention existing before the work was started but as a record to form the basis of settlement of disputable conditions arising during the performance of the contract. The importance of this feature of highway procedure and administration must appeal to you as being worthy of careful thought and attention. The schedule of work items must be complete as far as it is possible to make it so and should cover such items as may reasonably be expected to be encountered during construction; the specific clauses, explanatory of these items, should be thorough and conclusive as to requirements; the full and complete relationships of the parties should be established beyond question and with fairness; and the procedure should be defined with respect to the settlement of any controversies which might arise affecting the status of the agreement or conflicting with the condition of the real intent of the parties.

In order to achieve this result the observance of a few elementary and common sense rules will serve to relieve the uncertainty as to mutuality and the consequent intention of the parties. Of first importance is the necessity of clarity. What is worth specifying is worth inserting in such a manner that any person of the average intelligence may readily understand the intent and purpose and may be in a position to give full assent of accord. If clarity requires the sacrifice of brevity then there should be no hesitation in making the sacrifice. It is true that a volume could be written on any one of the many specification clauses but the rules of common need and understanding do not demand this. It is sufficient when the requirements have been so expressed with conciseness that there can be no reasonable doubt as to its meaning. Nothing should be left to guess at. In the early days a contractor's definition of a specification intimated that it was a set of rules for the contractor's use in guessing at the engineer's meaning. This condition has been eliminated and with it has gone practically all of the lack of mutuality. The omission of ambiguous, inconsistent and contradictory clauses especially in such instances where repetition is necessary; the correlation and grouping of the clauses under the proper headings so that the intent is conclusively and unquestionably shown as to which clause is intended to cover any specific item; and through it all the display of thoroughness in properly treating all of the requirements in their entirety without carelessness of expression or ignorance of the facts, these conditions will make possible the assurance of satisfactory performance during construction without expectation or need of charity or sacrifice to either party. In this way, and in this way only can intention be stated potently so that it will be effective. Comprehensiveness will come with completeness and the willingness to share obligation along with benefits will result favorably in the success of the contractual relations.

The burden of performance is on both sides. There is just as much of an obligation on the part of the contractor to inquire into these factors and to familiarize himself with the conditions as there is on the part of the contract writer to make his every want known and understandable. There must be a perfect balance throughout the agreement of equity, risk, benefit and satisfaction. There is no discharge of responsibility until the consummation of the contract and until that period has been reached the spirit of co-operation must permeate every thought, plan and action in the interest of completing the job with mutual satisfaction and in accordance with the real intent.

There are two other interesting

phases of contracts which are essential requisites. The matter of time imposes a condition upon the contractor which is second in importance only to the nature of the project itself. It has been often said that time is the essence of the agreement, meaning that is the idea of the action and the law or the constitution of its being. Without the imposition of the time element the quality of the contract is lost. It satisfies the condition that we not alone want the thing itself but that we want it when we want it. In order to achieve this result we resort to the use of progress schedules in order that a comparative check may be had upon the speed with which the performance is being accomplished. In this matter we must also adopt the policy of firmness in the face of incapacity and of compromise against the presence of unavoidable delays. In this connection we again meet the need of co-operation as well as of insistence that our desires be respected.

The remaining feature of interest pertains to the surety requirements in which the bondsman gambles that the contractor will complete the work faithfully and in accordance with the terms of the contract. The surity then becomes the indirect third party in as much as the agreement of indemnity is a contract collateral to the original construction contract itself. As it is not the purpose of this discussion to enter into the direct violative aspect of contracts the relationship existing between the parties will not be considered at this time. It will be sufficient to state that the surety obligation imposes the requirement of exercising due caution in the alteration of agreements affecting the status of the bond itself. As it is a protective instrument all care should be taken to safeguard our expressed rights in order that this protection will become real in case of default or breach of contract.

In conclusion it might be stated that our portion of the obligations in connection with the matter of contracts is clearly defined and through strict observance of the essentials outlined we may do much toward the satisfaction of successful performance. It then remains for the co-contractor to do his part in an honest and co-operative spirit. The net result will be better work, a more agreeable progress record, lower costs and finally a mutual benefit to all concerned.

COMMENTS ON CONCRETE ROAD CONSTRUCTION

By A. N. Johnson, Dean, College of Engineering, University of Maryland.

(Paper read at 1927 Highway Conference at University of Michigan.)

It is well to state the limitations that have necessarily been kept in mind in the preparation of this paper. The fact that this audience includes so many who have had as much or more extensive experience in concrete road construction than any other group of engineers in the country made the selection of material to be presented all the more difficult. What has been done is to present but a few phases of the subject with which the writer has had some personal contact or experience, and which, at the same time, would be of general interest to this audience. There are, therefore, obvious omissions of many important phases of the subject, the discussion of which is left to others who may participate in the presentation of this topic.

This paper contains a brief outline of the development of the use of concrete for road construction in the past, after which attention is centered upon a few points which are the results of recent developments in the art of building concrete roads. These developments have come about through extended experience on the part of highway engineers, and also as the result of scientific researches and studies which yearly add to the sum of knowledge at the disposal of the engineer.

Historical References

Concrete road construction, as we know it today, is a very recent development. There are, however, a few scattered instances of the use of concrete in road construction extending back nearly a century. The first was the construction of about one-quarter of a mile of road outside of London on the Highgate Archway Road, where a concrete base was laid in 1828 over which macadam was placed. The next use of concrete noted was for the foundation of an asphalt pavement laid in Paris about 1858. Concrete was first used as the wearing surface of a pavement in Scotland in 1865, and the following year another section was also laid in Scotland. The method of construction of these latter roads is of interest. Concrete was laid in layers of three or four inches, which was rolled and allowed to remain for three days before a second layer was

placed. It was recommended that the road should be left for three weeks before opening to traffic, though the engineer reported a week was found to be a sufficient interval.

It is stated that concrete was first used in America as a base for paving in 1888 in New York. A concrete pavement with concrete wearing surface was first built in Wichita, Kansas, but was not a success. The next concrete pavement of which we have record was laid in Bellefonte, Ohio, in 1892. Between 1896 and 1906 a number of concrete streets were laid in Richmond, Indiana.

But the use of concrete for highways may well be said to begin with the concrete road laid on Woodward Avenue in 1909 by the Highway Commission of Wayne County, Michigan. By 1912 a number of sections of highways had been built in Milwaukee County, Wisconsin; Cook County, Illinois, and some other points in the middle west, as well as in Wayne County.

From this date, the use of concrete for rural highways has developed very rapidly. For a somewhat more extended description of the earlier use and development of concrete highways, reference may be made to a paper by the speaker in the Proceedings of the American Concrete Institute, Vol 20, 1924.

Application of Highway Research to Subgrade and Concrete Slab Construction

The development of concrete roads has been greatly stimulated by research of a high degree of scientific attainment. The highway researches that have come about through concrete road construction have been especially marked. These have been carried on by many agencies, in particular the U. S. Bureau of Public Roads and the various State Highway Commissions, as well as by many universities.

One of these investigations to attract our attention is the series of experiments made by the Illinois Highway Department known as the Bates Road tests. A full description of the details of these tests and results have been very ably presented before the A. S. C. E. by Mr. Clifford Older, at that time Chief Engineer of the Illinois Highway Commission. His paper was presented January 17, 1924, and appears in full in the Transactions of the Society for 1924, page 1180. This series of tests consists essentially of many types of construction, extending over a distance of two miles, upon which trucks were driven with increasing loads until all of the weaker sections were destroyed. Apparatus for making measurements of the deformation of the concrete road slabs under various conditions of loading were devised, and in general, the results obtained confirm the fact previously ascertained by laboratory experiments as to the elastic properties of concrete to which further mention will be made.

We are concerned here not so much with the descriptive detail of these tests as with the results insofar as they may be usefully applied by the engineer in the construction of concrete roads. Perhaps, one of the most significant facts brought out is the behavior of clay subgrades through attempts to control the moisture content, for it is well known that the bearing power of clay soils varies with the moisture content, the greater this moisture content the less the bearing power.

It has been a practice by many engineers in preparing a subgrade through clay soils to resort to expensive side ditches and under-drains in order to reduce the moisture content of the soils. But the result of the careful observations and experiments made, as reported by Mr. Older, indicate these are of very doubtful value.

The report discusses in detail that along a 200 foot section a 24-inch drain tile was laid below the subgrade in a trench backfilled with cinders. No difference in the moisture content was noted for a period of three years between the soil of this section and a nearby section not provided with such drains.

There is further described a similar experience on another road with different character of clay soil, where tile drains were laid 42 inches under each edge of the pavement for a distance of 1,000 feet. These trenches were also backfilled with cinders.

The results here obtained show that the section provided with tile drain contained actually more moisture, throughout a period of over a year, than under the adjacent undrained pavement. Mr. Older concludes that "to judge from these two examples in which tile drains were of absolutely no apparent value, it is questionable whether such attempts to control the moisture are of any merit whatever in clay soils."

As a result of further observations on the moisture content of the clay sub-

grade underlying the Bates Test Road, it was found that the moisture content of the subgrade at the time of construction was evidently an important factor in the amount of moisture that may be found in such subgrades, at least for a period of a year or more after the pavement is laid.

For example, on a section of the road laid in a rainless period in hot weather, which preceded the construction, it was found that during the following October it reached nearly a point of saturation, whereas another section laid at the time the subgrade contained about 25 per cent of moisture did not, throughout the winter following, show any increase in the amount of moisture in the sub-grade.

Mr. Older ascribes this result to the fact that if during the summer the moisture content was normal, the clays resisted further saturation; on the other hand, if they were extremely dry when the soil crumbled readily, subsequent absorption to the point of saturation takes place very rapidly. These observations suggest the desirability of thoroughly wetting a very dry clay subgrade upon laying concrete.

The extensive investigations carried on by the U. S. Bureau of Public Roads are in part reported in the transactions of the A. S. C. E. for 1925, page 264, in an article by A. T. Goldbeck describing in detail the results of numberous subgrade studies. These confirm many of the conclusions arrived at by Older. From these latter investigations, perhaps the most important conclusion to be drawn by the highway builder is that one of the most effective protections against soft clay subgrade is a layer of sandy or gravelly soil (or similar granular material) which has a very low capillarity. This form of construction in particular gives protection against frost action.

Another important result as the outcome of the Bates Road Test was the adoption of a cross section with a thickened edge, using actually a smaller amount of concrete per mile, yet producing a road slab which showed greater resistance to heavy traffic than the usual cross section thickened at the center. The conclusions in this particular from the Bates Road Test were so obvious that within one or two years from the date of the publication of the results, this cross section had been adopted by thirty-nine states. The section designed by Mr. Older is one with an edge thickness of nine inches tapering to five or six inches two feet from the outer edge, the remainder of the slab having a uniform thickness of five or six inches. It was noted that at the end of the traffic test this section remained in excellent condition and that no damage had occurred which would cause additional maintenance cost.

Effect of Steel Reinforcement in Concrete Roads

There is, perhaps, no point in connection with the construction of concrete roads about which there has been more speculation than as to the effect of steel reinforcement. Many experimental sections of roads reinforced in various ways have been constructed, as well as extensive stretches of road in which steel reinforcement of various kinds have been employed. There were, however, at hand no comprehensive digests of the results until such a study had been undertaken by the Highway Research Board in 1925, when, through the cooperation of the manufacturers of steel reinforcement, there were made possible sufficient funds to carry on a special investigation, which was done and a report made. This report forms part 2 of the Proceedings of the Fifth Annual Meeting of the Highway Research Board, December, 1925.

An examination of this report is necessary before adequate idea may be had of its extent. These comments are but fragmentary, and made for the purpose only of exciting sufficient interest for you to examine, at first hand, the report itself.

A few of the conclusions drawn, ably supported by adequate data, are presented in the report as a summary of conclusions, and are repeated here. From them many useful suggestions of practical value to the highway engineer will be found.

"1. The amount of cracking and subsequent disintegrating is a function of time; thus, the rate of cracking is a measure of the life of the pavement.

"2. The data show that steel reinforcement reduced the rate of cracking and thus increased the life of the pavement. This applies to both concrete pavements and other pavements laid upon a concrete base.

"3. Crack reduction is more economically accomplished by the use of steel reinforcement than by additional thickness of concrete.

"4. A greater reduction was afforded by small steel members closely

spaced than by larger members widely spaced.

"5. Increasing weight of mesh from 25 to 56 lbs. per 100 square feet considerably reduced cracking.

"6. Mesh reinforcement, 25 to 56 lbs. per 100 sq. ft., reduced cracks 35 to 70 per cent in pavements of like thickness.

"7. Mesh reinforcement, 25 to 56 lbs. per 100 sq. ft. and bar mat reinforcement 64 lbs per 100 sq. ft.—25 per cent longitudinal—reduced cracks more than one additional inch of concrete; but one additional inch of concrete reduced cracks more than bars (42 to 48 lbs. per 100 sq. ft.) placed tranversely only.

"8. With good crushed stone aggregate, 56 to 90 lbs. per 100 sq. ft. mesh reinforcement, or 170 lbs. per 100 sq. ft. bar reinforcement, 50 per cent each way, caused a reduction in combined transverse and longitudinal cracks equal to that indicated for 2 inches additional center thickness.

"9. Mesh reinforcement of 38 lbs. per 100 sq. ft. has been effective for a thin layer of concrete laid as resurfacing upon an old concrete road.

"10. One additional inch of edge thickness reduced corner cracks more than mesh reinforcement 25 to 56 lbs. per 100 sq. ft. or 3-8 to 3-4-inch bar reinforcement; but progressive destruction following the appearance or corner cracks was arrested by steel reinforcement.

"11. All types of steel reinforcement across cracks tended to hold together fractured slabs.

"12. Bar reinforcement across transverse joint, without proper provision for slippage and clearance, resulted in breakage and subsequent expensive repairs.

"13. For long slabs, 75 to 100 feet or over, edge bar reinforcement with continuous bond caused corner cracks in the area of steel exceeding 1-4 sq. in.

"14. A remarkable agreement was found to exist between results of observations of roads in service and results furnished by a wide range of experimental roads and laboratory tests."

Effect on Strength of Concrete Hauled From Central Mixing Plant

It is frequently convenient to have a central mixing plant and haul the concrete ready mixed to the job. For example, it is often necessary to widen an existing road, which may be done effectively by the construction of concrete shoulders on each side. If a mixer were on such a job it would interfere much more with the maintenance of traffic than if no mixer were required. Particularly have central mixing plants been found useful in city pavement construction. The results of the tests of the cores drilled from concrete that was hauled varying distances is, therefore, of particular interest.

Under the charge of the State Roads Commission of Maryland a central mixing plant was set up at Muirkirk on the Baltimore-Washington Road to furnish the concrete for shoulders which extended four miles on each side of the road. Cores were drilled from these shoulders a year later and tested at the laboratory of the University of Maryland. These cores were drilled on each side of the road at one-quarter mile intervals, three cores being taken at each point. The results of the crushing strength of these cores showed a steady increase in strength as the distance hauled increased up to three miles, the average increase being from 3,000 pounds to a little over 4,000 pounds; the subsequent distance up to four miles showed a slight drop from the maximum, but gave strength tests decidedly greater than for the concrete that had not been hauled.

The conclusions reached from these results are that a least up to four miles haul the concrete did not suffer any decrease in strength, but rather showed an increase, and that so far as the strength of the concrete was concerned, four-mile hauls may be safely made. Thus it is a matter solely of practical and economical handling of the work whether the concrete would be hauled as great a distance as the four miles.

Development of Curing Methods

Some attention has been paid recently to methods for curing, other than by application of wet earth to cover the roads, or by ponding. Due to the many instances where, because of dry weather or the remoteness of a sufficient supply of water, a practical method to cure a concrete road surface without use of water has become increasingly important.

The use of calcium chloride sprinkled upon the surface of the road has been tried. The admixture of calcium chloride in the concrete, also the surface treatment of the newly laid road with silicate of soda solution are still other methods. The latter particularly gives considerable promise of being effective and reasonably economical. A test was

made during the summer and fall of 1926 by the State Roads Commission of Maryland in co-operation with the University of Maryland and the U. S. Bureau of Public Roads, using three methods of curing. The first method was to cover the concrete with moist earth in the customary manner; second, a surface treatment of silicate of soda diluted with 25 per cent water; third an admixture to the concrete of sodium chloride, 100 pounds being dissolved in 42 gallons of water, which made approximately 50 gallons of the solution. Two quarts of this solution were added to the concrete for every bag of cement.

As the result of crushing strength tests of 30 and 90-day cores drilled from sections of the road cured in these various ways, it was noted that the surface treatment of silicate of soda gave somewhat greater crushing strengths than either of the other methods, thus indicating that concrete cured with the silicate of soda gave as good or better concrete than was produced by the other methods of curing. Whether the damp earth method would be used in a given case would probably rest upon the relative cost.

Major H. D. Williar, Assistant Chief Engineer of the State Roads Commission of Maryland, reports that the earth road curing averaged 4.3c per square yard, the admixture of sodium chloride 5.1c and the silicate of soda a little over 3c. It was further noted by Major Williar that about 15 per cent of the road cured with the earth covering was somewhat cheapened because of the fact that due to cooler weather it was not necessary to cover it.

In connection with these tests, it is proper to note that there is a marked difference in the crushing strength of samples of concrete taken with cores drills, and cylinders of concrete cast in molds, even though the latter are filled with concrete from the same batch that goes into the road slab. Thus while the cylinders showed a breaking strength of perhaps 2,000 pounds, the cores would indicate in the neighborhood of 3,000 pounds per square inch crushing strength.

This is of interest in connection with the fact that recently in the City of Duluth fourteen blocks of concrete pavement, which it was decided to open to traffic as early as possible, were constructed of an especially rich mixture, 1:11-2:2 1-2, and the street opened to traffic as soon as cylinder moulds from the concrete as placed in the street reached a strength of 2,000 pounds per square inch, which I am informed was within four days. There is every reason to suppose that had cores been drilled from this pavement, the crushing strength would have been found to be considerably greater than that recorded for the moulded cylinders.

Improvement in Methods of Finishing Concrete Roads

The hand finishing method by wooden trowels which was used in the building of earlier concrete roads left much to be desired as to quality of road surfaces. Striking templets, used with rollers and belts, were a great improvement over the hand finishing method, and led up to the development of road finishing machines. The machines most generally in use had a combined striking and tamping effect. But it was found that the result of the tamping action was to flush to the surface a layer of mortar which subsequently would scale in spots. To remedy this, these machines have been modified so as to eliminate the tamping effect, and in its place produce more nearly the result that is obtained by pushing over the surface a very heavy screed compressing the surface by squeezing it rather than by tamping. In fact, a concrete road surface that is finished by a heavy screed worked by hand, as was common in the early practice in Delaware and much used in the concrete roads in North Carolina, produces a very satisfactory surface.

Shoulder Construction Important

One of the most important features in construction and maintenance of concrete roads are the shoulders.

It is generally agreed that the practice of stopping vehicles on the traveled way proper, especially of a two-lane road, causes great inconvenience to other travelers, and adds a very serious element of danger, both of which increases very rapidly with increase in the relative amount of traffic.

It has been proposed that a traffic regulation should provide that for no reason whatsoever shall a vehicle be allowed to stand within ten to eleven feet of the center line of the traveled way. If such a regulation is to be practicable, it would be necessary to construct shoulders of sufficient width (five or six feet) for a vehicle to stand upon. The shoulders when adjacent to a two-lane width of not less than eighteen feet

would not be expected to carry traffic, nor need there be constructed for this purpose, unless upon long grades exceeding 4 to 5 per cent, other than good sod shoulders, for when such shoulders are established they resist erosion remarkably well.

On steep grades in cuts, it will be necessary to modify the shoulder width. One of the best methods of construction under such circumstances is to carry the concrete for ten or twelve inches upon the slope, thus having the pavement itself form a gutter, the total available width being not less than twenty-four feet. This would permit a vehicle in an emergency to be parked at the side of the road, and still leave reasonable space for two lines of moving vehicles.

Core Drill Tests

It has been the practice in the past few years in a number of states for the State Highway Commission to take samples from concrete roads by drilling cores. Special core drilling apparatus has been used for this purpose, consisting essentialy of a soft steel bit, the cutting being effected by small hardened steel shot. These core samples make it possible to examine the texture of the concrete, check the thickness, and obtain the crushing strength which affords some measure of the relative value of the different concretes.

The State Roads Commission of Maryland has taken several thousand core drill samples, this work being placed immediately under the charge of the Engineering College of the University of Maryland. An examination of the results has led to one very pertinent point. For example, a number of cores close by one another, presumably from the same mix of concrete, should theoretically give the same crushing strength. Practically, this is not the case. If we take the mean of value of such a group and determine the percentage of variation of each individual of such a group from the mean value, we get values ranging from zero to perhaps 30 or 40 per cent. Such values were obtained for upwards of 1,600 cores, and it was found that the mean variation from these group means was about 8 per cent. An examination of crushing strengths of 6,000 concrete cylinders made in the laboratory under strictly controlled conditions showed a mean variation almost identical with that found for the cores drilled from the road.

Several hundred results of tests on steel specimens, however, gave a mean variation of less than 2 per cent, indicating that this value of the mean variation is indicative of certain definite characteristics of the materials tested. We may expect, therefore, to find a greater variation amongst the values from tests of concrete than from tests of steel. If in comparing results of concrete tests, for example to discover the effect of a different method of mixing or other variation in the method of making the concrete if our results do not persistently show greater than 8 or 10 per cent difference, we cannot draw too nice conclusions as to cause and effect.

Elastic Properties of Concrete Determined by Tests

In the past few years there has been conducted at the University of Maryland a fairly extensive series of tests to measure the elastic properties of concrete. Such measurements had been made in the past, but from the nature of the apparatus used, the resulting stress strain diagrams were unsatisfactory in that they led to the wrong concept of the elastic curve of concrete, indicating that concrete even under comparatively low stress acted as a material having marked plastic properties, rather than elastic.

For the measurements made at the University of Maryland, there was employed a simple arrangement of the mirror extensometer, so that much more accurate and delicate measurements were made possible. The essential fact that these measurements have established is that concrete up to a fairly definite limit acts essentially as elastic material in a manner similar to that which steel exhibits, and that beyond this limit it shows the characteristic stress strain curve for an elastic, plastic material, the limit of the straight line relation indicating the elastic limit which may be about as definitely located for concrete as for steel.

These tests show that the modulus of elasticity for concrete is for all practical purposes a constant up to certain definite stresses, and that there is no occasion for defining the modulus elasticity of concrete as that at a certain point on the stress strain curve as has been previously reported by some investigators.

The fact that we may treat concrete as an elastic material, and subject concrete structures to analysis by the theory

of elasticity is very handsomely confirmed by the results of measurements of the deflection of a concrete road slab under different loads as measured in connection with the Bates Road Tests, and other tests conducted by the Bureau of Public Roads at Arlington. The mathematical analysis of the action of a concrete road slab under elastic conditions is presented by Dr. Westergaard in the Proceedings of the Highway Research Board of 1925 and 1926.

Progress of Work Has Been Stimulated

Much attention has been given to factors that would influence the progress of work. Weather conditions that prevail in a large part of the United States make highway construction, of necessity, a seasonal occupation, but as the amount of work to be done has increased, highway engineers and contractors found it necessary to cooperate even more closely than in the past, to the end that everything possible be done to increase the output of finished road. Thus, provision has been made for storage of materials for the winter months, with advance payments for the same; contracts have been let in the fall for the coming season's work, all of which has made it possible for contractors to maintain better organizations throughout the year, with a consequent saving of much time, in the spring at the opening of the construction season. Whatever has been done to facilitate work has resulted in economy, not only to the contractor but to the public.

The development of road machinery has played a very large part in speeding up work. In fact, the labor situation has become such in the past few years that unless labor saving machinery had been devised, the work could not have been done. Thus, it has come about that on most concrete jobs but few men are employed who do not handle machinery of some character, reducing to a minimum the purely hand labor portion of the work.

It is necessary only to visit the Chicago Road Show with it enormous collection of road-making machinery of all sorts to realize how great has been the labor saving devices that have been developed, and for the most part but recently developed.

Data as to the progress that has been made are of value to engineers and reference to these data will be made here. At present the average yardage per contract for highway work is about 33,000 square yards. In 1926, one of the larger contracts was for 169,000 yards in North Carolina, and one was for 182,000 yards in Illinois.

Data as to the records of laying concrete roads are found in the November 1926 "Public Roads" magazine, where it is shown that a mixer turning out the possible maximum batches (48) 13 per cent of the time was for charging, 83 per cent for mixing, and 4 per cent for discharge.

In the Engineering News-Record for June, 1924, page 1063, are to be found some very pertinent data as to the seasonal progress made by different crews on state highway work in Iowa. The record extends for over three years. The average number of feet per day was about 270. Pavement was laid on an average of about 70 per cent of the time. Such data as those to be found in this article are of special value in determining the organization necessary to carry on a given season's road-building program.

In general, in the past few years a marked increase in the use of the larger mixers, the No. 28 and No. 32-E is to be noted, although the 21-E size still remains the one most commonly used.

One of the most complete studies of progress in concrete road construction is to be found in the series of articles by J. L. Harrison of the Bureau of Public Roads, beginning in the November, 1925 number of "Public Roads" magazine. This series should be studied by everyone interested in this phase of the question.

The latest figures obtainable as to the amount of concrete pavement on our highways are the figures compiled by the Bureau of Public Roads up to 1926, which shows a total of 27,875 miles on the state highway systems and 10,106 not on state highway systems, a total of 37,981 miles.

IMPORTANCE OF UNIFORM MOTOR VEHICLE LAWS

By S. J. Williams, Director, National Safety Council.

Automobile fatalities in the United States in the year 1925 totaled 21,627 according to a recent announcement of the Census Bureau. This represented an increase of at least nine per cent over the preceding year. Ten years ago the

total was less than 8,000. Twenty years ago it was less than 600. In those twenty years the automobile has been developed—but at what a price in human life!

In 1926 the automobile death toll was about 23,000, judging from advance reports which the National Safety Council has secured from twenty-eight states and one hundred cities. This estimate represents an increase of five per cent over the preceding year, as contrasted with the previous increase of over nine per cent. This indicates that at last we are beginning to make some impression on this great problem. If we are, it is because many of the larger cities and several of the more thickly populated states have been making desperate efforts to cope with the situation and many of these showed an actual decrease in automobile fatalities in 1926, including the states of Massachusetts, Connecticut, Ohio, Kentucky and a few others, and the cities of Boston, St. Louis, Kansas City, Louisville, Minneapolis, Jersey City, Columbus, Erie, Hartford, Paterson, Providence, St. Paul, Toledo, Worcester, Youngstown, Salt Lake City and some smaller places.

I have heard many bitter arguments regarding the causes of and the remedies for automobile accidents, but I have never heard any one dissent from the proposition that we need good laws and we need uniform laws. The difficulty has been in agreeing on what constitutes a good law. Various organizations have produced model vehicle laws in the past, but none of them represented a general agreement until Secretary Hoover called together the National Conference on Street and Highway Safety. This conference did other things, but its greatest accomplishment, I believe, was in securing agreement of over a thousand delegates, representing practically every state in the union and every conceivable business or other interest, on the Uniform Vehicle Code. This code represented more than a year of hard work on the part of a committee of thirty-seven members, public officials, judges, engineers, lawyers, automobile men, railway men, representatives of women's clubs and of labor organizations. These various members and the great organizations and constituencies which they represented, contributed every available scrap of information and experience bearing on the subject. On the legal side, this committee co-operated with, and the code was later submitted to, the National Conference of Commissioners on Uniform State Laws which officially represents every state in the Union and which is also a section of the American Bar Association.

What is the substance of the code thus produced? I shall pass over the first two parts, dealing respectively with the registration of vehicle—the ordinary license tag—and with the certificate of title for prevention of theft.

The third part of the law deals with the licensing of drivers—both professional chauffeurs and private operators. This is vitally important. Official figures show beyond question that the eastern state, which have had drivers' license laws for several years, have, in general, a very much better record than have the other states. A drivers' license law, honestly and energetically administered, will accomplish two things. It will require new drivers to learn how to handle a car, and to learn something about the motor vehicle laws and rules of the road, before starting to drive on the public highway unattended. And secondly, by providing for revocation of the licenses of those convicted of serious or repeated violations of law, it will remove from the highway the irresponsible and chronically reckless driver. A drivers' license law will not at once stop all accidents; it will not stop any unless it is properly administered; in any case it will not touch materially that class of accidents caused by momentary thoughtlessness or chance taking on the part of a normally good driver. But, judging from the experience of other states, this law may be expected, with proper enforcement, to cut down accident rates by twenty-five per cent.

The fourth part of the uniform code deals with rules of the road and other regulations governing the operation and equipment of the motor vehicle. It is on this subject that uniformity among the different states is so obviously desirable. I need not expatiate on the manifold troubles of the motorist going from state to state or even from city to city and trying to accommodate himself, like a chameleon, to the ever-changing regulations, I shall not attempt at this time to go into the specific provisions of this law, on such controversial subjects as speed, except by saying that every one of these provisions was discussed by the hour in our committee meetings and I believe that the present provisions of the

code represent the very best standard that can be generally agreed upon throughout this country. I believe that every public official, and every private citizen—for each one of us considers himself a traffic expert—should take the attitude that was expressed by the Motor Vehicle Registrar of Pennsylvania in a recent conference which I attended, when he said, "I don't agree with anything in the Hoover Code, but I am willing to accept it without changing a word, because, if we sincerely believe in uniformity, I don't see how we can ever get uniformity unless we accept this uniform code."

The National Safety Council is a great believer in education as the cure for accidents of all sorts. Our sixty-five local councils, as well as the National body itself, are engaged chiefly in educational work. But education must have a solid foundation. We must impress on the growing child, and the adult motorist and pedestrian, the overwhelming importance of personal carefulness in the use of the streets, but we cannot stop with simply saying "Be careful!"—we must tell the child and the adult what he must do and what he must expect that others will do; that is, we must have laws governing the use of the highway. I believe also in the tremendous importance of adequate law enforcement. I agree with the man who says "What we need is not more laws, but better enforcement of laws"—but I respectfully point out to him that one big reason for unenforced laws is unenforceable laws. Give your police, your sheriff, your judges, a reasonable, practicable, up to date law—then get behind them and insist on enforcement of it.

MUNICIPAL AIRPORTS

(From an article by R. E. Gossage in "Municipal Reference Library Notes" issued by the New York Public Library.)

The era of air transportation is slowly but surely, beginning in United States. If we are rather far behind the Continental air service developments in many respects, we have made what progress has been achieved without the aid of federal subsidies. Now that the Kelly Air-Mail Contract Law and the Air Commerce Act, have been written into the law of the land, we have, undoubtedly, prepared the way for a well-regulated and an early developed air commerce.

W. D. Glover, Assistant Postmaster General, who is in charge of our successful Air Mail Service, forecasts a rapid expansion of private aviation in America, and urges the imperative need of Municipal airports as essential adjuncts to city transportation facilities. At the annual meeting of the Aeronautical Executive Association, it was predicted that Canada and United States would be linked by air in 1927. "We have" said an expert of that Association, "the right kind of pilots and airplanes in commercial use, but we must have more airports."

Of the 3,608 landing fields and airports reported by the Aircraft Yearbook of 1926, 310 are listed as municipal airports. But many of these are unimproved fields. The Kelly Mail Act, however, stimulated many cities into action, causing them to set their fields in order that they might thereby obtain air mail routes.

The year 1925 was a year of definite progress. Aviation became something more than barnstorming. It received recognition as a business by the entrance of some of our foremost capitalists and saw large financial investment in air transport systems. During the year, close to five and a half million miles were flown and over 200,000 passengers were carried. Twelve air mail routes (mileage of about 5,500) were let to private operators. At the beginning of 1926 nearly 9,000 miles of commercial airways were in regular operation in United State. In a year and a half of the Air mail service ending December 31, 1925, 16,414,296 letters were carried, $1,037,-524 excess postage being collected. Out of this sixteen and one-half million letters only 4,000 were lost. Certainly a marvelous record, when one remembers that the mail planes must fly day and night in all weather, over mountains and through blizzard and cyclone regions.

When the statistical data for 1926 and 1927 become available, indications are that it will reveal satisfactory progress. Air Express will have become an established system of transportation. The close of 1927 may see passenger transportation assume important proportions.

That cities are becoming increasingly aware of the importance of being linked successfully to Airways is evident. As the Government is definitely pledged to put the air mail transportation in private hands and has taken over the regulation of the Airways there is every incentive for those cities, alert to advantages to be gained by an adequate airport, to push

to completion or enlarge their present airfields.

Cleveland is one of the cities that has seen to it that its airport is large enough and sufficiently well planned to place it definitely on the Airway map for some years to come. Legal obstacles were hurdled, $1,125,000 was appropriated and 750 acres purchased. On July 1, 1926, after one year of operation, 4,000 planes had landed and taken off from the Cleveland airport. St. Paul issued bonds for $295,000 for the development of an airport. The port opened on June 7, 1926, ready for the use of Mail planes on the Chicago-Twin City route. It is admirably situated both for aeronautical and commercial purposes. The San Francisco Regional Plan Association is advocating a Metropolitan aviation center on the Embargo. It is proposed that an Airport landing platform 150 to 200 feet above the high water mark and about 1,000 feet by 1,000 feet in extent be built over the wharves. It is also proposed to build in conjunction an elevated highway similar to the structure planned for New York. This roadway would be built along the wharves past the airport. The scale of the plans for the elevated airport appears to be on the dimensions of those great foreign airports such as Corydon for London, Le Bourget for Paris or that of Tempelhofer in Berlin. In order, however, to get in on the Airmail routes, the Board of Supervisors have taken a hand and are considering a plan to develop a temporary field on the Marina. San Francisco appears determined to take its place as a leading port on the Airways.

The activities of a half dozen other cities might be mentioned here. But the question comes closer home. What is New York City doing about an airport? As yet, not very much. There is reason to believe that New York should be the Main Air terminal and the fact that the City has had no accessible, adequate terminal has undoubtedly retarded Air transportation. At present, the Air Mail for New York arrives at New Brunswick, N. J., an hour's ride by railroad express to the city. The Mineola Field, Long Island, is about 15 miles from the Pennsylvania Station. On September 23, 1925, four sites were proposed for consideration to the Board of Estimate by Chief Engineer Tuttle. In his report the Chief Engineer said: "that in his judgment, it would be a farsighted policy to prepare for the invasion of the airplane in the field of transportation, trade and commerce, and that the City should take active steps in the near future to set aside at least one site for ultimate development as a Municipal air field to be operated by the City, and that the day is not far distant when such a field will be self-supporting." Mayor Walker, at a public hearing on November 11, 1926, appointed a Special Committee on Landing Fields. The members appointed were: President McKee, of the Board of Aldermen, Comptroller Berry, and Borough President Bruckner. They are to report before another hearing is held.

The Merchants Association, which has been actively working on Air projects for New York City, first asked that Governor's Island be considered as a desirable airport. The Federal Government, however, refused to relinquish its military station. Not deterred by this, the Association at the hearing of November 11, then proposed another location of a much larger area. This site consists of 400 acres of salt flats in New Jersey near Secaucus. The advantages claimed for this location as New York's Airport are numerous:—Its accessibility for Air mail, express and passenger traffic, since it is situated at the mouth of the Pennsylvania tube, just 4 miles from the General Post Office. Both the Erie and Pennsylvania roads could readily connect with it. The cost for development would be moderate. The Association estimates that to be about $2,500,000. The area of this site is said to be large enough to accommodate the increasing air traffic of the entire metropolitan area for years to come. It is ideally accessible to the center of this zone. It would be economical in that it would eliminate expensive storage now required. As most of the Air traffic would come from the West and South, it would be a logical site; it would also eliminate dangerous over-city flying. The Association declares there are no legal obstacles that prevent New York City from acquiring this site in New Jersey and proposes that the City of New York make it the main Air terminal of the East.

WIDER PAVEMENTS VS. ALTERNATE ROUTES

By A. W. Dean, Chief Engineer, Massachusetts State Highway Commission, Boston, Mass.

(Paper read at 1926 meeting of American Association of State Highway Officials.)

The abbreviation "vs." in its most com-

mon use signifies a contest or battle, either athletic or legal, but as used in the title of this paper on the program it can have no such significance, as the wide pavement and the alternate route each has its own field of eminence, as does the boxer and the wrestler.

Through routes are annually becoming more congested with traffic and necessity very widely exists for a greater width of pavement in some instances and alternate routes in others. It has been quite thoroughly demonstrated that adequate pavements should be designed on a 10-ft. unit basis, meaning 10 ft. in width for each line of vehicles. It would appear at first thought that the width should be in even multiples of 10, that is 20, 40, and 60 or greater widths. Nevertheless it is found by actual observation of results that a pavement on rural roads 30 ft. in width actually carries practically double the vehicles per hour as does the same pavement 20 ft in width, the explanation being that the traffic in one direction is greater than in the other direction, and a 30-ft. pavement provides for two lines of vehicles in one direction and one line in the opposite direction. Particularly on routes leading into large cities it is very evident that there is a large amount of traffic toward the city in the morning hours, with a small traffic leading out of the city, whereas in the afternoon the nomical to be governed by the peak loads of traffic where such peak loads occur only three or four times per year, but the roadway should be of sufficient width to take care of the frequent or daily peak loads.

A most serious objection to very wide pavements is the difficulty in handling traffic of both vehicles and pedestrians at intersections. In most instances it is impracticable to control traffic at intersections by any automatic device hence the presence of a traffic officer becomes necessary for the safety of the travelling public.

In some of the older cities where much traffic is necessarily confined to one artery, wide pavements are necessary, but in cities that have been planned during the last century the street arrangements are such that extremely wide pavements are unnecessary, as alternate routes through parallel streets may be easily adopted. These alternate routes in cities may be made of greater traffic capacity by establishing one-way traffic rules with right angle turns. On routes between centers that are some distance apart the topography and local conditions have great bearing in determining the advisability of wide pavements or parallel routes. In hilly sections the cost of constructing wide pavements, while not necessarily prohibitive, might be so expensive as to warrant the construction of a parallel route, that is, two parallel routes might be constructed under these conditions at less expense than one wide route.

In the more thickly populated States there are existing ways that could be utilized as parallel or alternate routes if properly reconstructed, and where such conditions exist the construction of an alternate route is much to be preferred, as it leads to a development and increase in value of property, said increase being nearly double what the increase would be if only one route is constructed.

The policy is suggested, therefore, that the extremely wide pavements be constructed only at the immediate approaches to large cities, where large volumes of traffic are of necessity converged to one artery, or where the distance is comparatively short between largely populated cities, in which case the tendency of all travelers is to take the most direct route.

Wherever these pavements are 60 ft. or more in width, safety islands should be provided for pedestrians, and careful regulations should be made and enforced to insure the safety of all travel at intersections or crossings. Elsewhere and at all places where feasible, the policy is suggested that alternate routes be constructed. Utilizing existing parallel roads where properly located, straightening them where necessary, connect up missing links by building on new locations, bypass the small business centers and also the large ones where possible, and you will then have a route that is logical and desirable for the long distance traveler, leaving the original route for the local travel and thus effectually dividing the traffic and relieving the congestion in business centers.

FEATURES OF NEW STREET LIGHTING AT ST. LOUIS, MO.

Before any interruption could reach the new electric street lighting system of St. Louis, the first unit of which was recently opened at Anne Avenue, a great disaster would have to fall upon the generating equipment or the high voltage transmission lines of the Union Electric Light and Power Company.

The system is controlled from a number of substations similar to the Anne Avenue station, functioning automatically even to the point of turning the lights on and off at the correct time each day without manual effort. But the initial power source of the system is the Union Electric's 13,000-volt feeder lines, two of which enter the Anne Avenue Station.

Two other stations are now under construction at 3116 Franklin Avenue and 3717 Blair Avenue.

Contracts for the first section of the city's $8,000,000 street lighting project were let a year ago to A. M. Ryckoff, general contractor of St. Louis. The stations are equipped with automatic apparatus of special design, built by the Westinghouse Electric and Manufacturing Company.

An area of three and one-half square miles, bounded by Arsenal street, Compton Avenue, Chouteau Avenue and the Mississippi river, is included in the Anne avenue territory, serving 3,923 lights mounted on hollow-spun granite standards.

The automatic features of the station are many and diverse. When the time arrives for turning on the lights in the evening, the station clock closes a contact which sets in motion a sequence of automatic operations. The clock is motor wound, and is equipped with an astronomical dial which changes with the seasons.

An auxiliary circuit which governs all the automatic apparatus, is set in operation with the closing of the time contact. The first operation is testing the seven branch circuits which radiate from the station to the surrounding district. If these branches are open, as they should be, an "open-circuit" relay closes and locks itself. In turn, a "master sequence" relay is started up. This relay contains a motor-driven contact drum, two revolutions of which will account for all the rest of the automatic working of the station.

The first of the master sequence contacts connects one of the incoming 13,000 volt lines to the station bus-bar or main panel. If there is no current in this feeder, the bus-bar contact will be connected to the other incoming line. If there is no current here either, the relays controlled by the first contact will trip the master sequence relay immediately and prevent its further operation until current is supplied on the feeder lines.

After the station bus-bar is connected to a live incoming line, the master relay drum continues slowly to rotate. After five seconds, the second contact is closed. A control relay is actuated which causes the first of the seven branch switches to be electrically closed. The other six branches are connected to station bus at intervals of five seconds by similar operations.

After the last circuit has been cut in, the auxiliary control circuit which operates the master relay, is opened automatically, stopping the drum at the end of two revolutions, in position ready for its next use. Normally, it would be used again near daybreak when the astronomical dial silently says "lights out." But if trouble were to develop any place in the system during the night, the master relay again would be called into play, this time to reverse its previous operation by "kicking out" the branch circuits and disconnecting the incoming lines from the station bus-bar.

Each of the branch circuits at the station goes through two constant-current regulators. The regulators function also as transformers, stepping down the voltage from 13,000 to 1,500 volts and supplying a steady current of 20 amperes to the branch circuits.

Aside from cleaning and oiling of movable parts, and general work about the station, no attendant is required. If something were to happen to a pair of the regulators, an inspector would go to the substation and throw one switch which would automatically cut in a spare unit to take the place of the disabled one.

The automatic features of the new system are important both as labor-savers and as protection against human fallibility. For the purpose of inspection and testing, the apparatus has been designed so that it may also be operated manually.

CURRENT RESEARCH PROJECTS OF U. S. ROADS BUREAU

By H. S. Fairbank, Highway Engineer, U. S. Bureau of Public Roads, Washington, D. C.

The following is a condensed statement of the status of the more important research projects of the Bureau of Public Roads current on Dec. 31, 1926.

Motor Truck Impact Tests—The impact tests are still one of the most active researches of the bureau. Tests to determine the effect of the thickness of tread rubber on impact reaction have been com-

pleted and the data are being analyzed. Looking toward the practical application of impact studies to highway engineering design and motor vehicle regulation the bureau is engaged in a program of field tests wherein actual pavement surfaces of various degrees of roughness are being compared in connection with the other major variables of tire equipment, load, and speed. It is expected that the data obtained will give valuable practical information on the magnitudes of the impact reactions to be expected when known conditions of the four major impact variables obtain.

A study of the instrumentation is being pursued by both theoretical and experimental methods with the idea of knowing definitely the accuracy of the data under the several test conditions.

Vibrolithic Concrete Tests—One-year tests of vibrolithic and normal concrete slabs have been completed. A report will be published shortly in *Public Roads.*

Other Concrete Tests—A series of field tests is in progress for the purpose of comparing the several methods of curing concrete pavements. In addition studies are in progress for the following purposes: To determine the effect of reinforcing on the distribution of transverse cracks; to measure the coefficient of subgrade friction; to make experimental comparison of three methods of concrete pavement curing in cooperation with the State of Maryland; to develop methods of protecting concrete against alkali and salt water with special reference to the use of water-gas tar; to investigate the water-cement-ratio method of proportioning concrete, in cooperation with the New Jersey State Highway department; to make fatigue tests of mortar and concrete and tests of the expansion and contraction of concrete subjected to various moisture and temperature conditions, in cooperation with Purdue University; to study the relation between the strength of Portland cement and the strength of the concrete in which it is used, in cooperation with the State highway laboratories; and an elaborate series of tests on the effect of the type and quality of coarse aggregate on the resistance of concrete subjected to repeated frost action.

Bridge Tests—Tests of two experimental bridge slabs constructed for the purpose of determining the value of the floor design of the Philadelphia-Camden bridge have been completed.

Stability of Bituminous Paving Mixtures—In cooperation with the American Association of State Highway Officials, a series of tests is under way to determine the relative stability of compressed cylindrical specimens of bituminous mixtures at 140 deg. F., 77 deg. F., and 39 deg. F.

In addition to this an extensive survey of roads in the far western states is being conducted for the purpose of developing an intermediate-cost bituminous surface suitable for that section. The South Carolina State Highway Department is cooperating also in a study of the various bituminous surface treatments for earth roads.

Subgrade Investigations—The most active investigation is that which has for its purpose a logical classification of soils with regard to their physical properties. The investigation aims at the development of correlated subgrade information with respect to the soil types shown on the maps of the U. S. Bureau of Soils. This will make these valuable maps of still greater usefulness to the highway engineer.

The investigation includes laboratory studies in cooperation with the Massachusetts Institute of Technology and field observations of the relationship between soil types and road surface conditions.

Highway Transport Surveys—Traffic surveys similar to those already published are completed in Pennsylvania and Ohio, and reports, now in preparation, will be published in a short time. Other surveys have been completed in New Hampshire and Vermont.

The following researches and tests are also in progress: investigations to develop and standardize certain tests for concrete aggregates; investigations to develop and standardize the direct tensile test for concrete and the stability test for bituminous mixtures; studies in cooperation with the University of North Carolina, to determine the strength of various kinds of culvert pipe under actual fills, field studies of landslides in relation to highway location, construction, and maintenance, in Ohio and West Virginia; and the effect of highway improvement on rural land values.

Probably one of the most important investigations is that aimed to discover the causes of low efficiency in road construction methods with special reference to grading operations and the mixing and placing of concrete in pavements.

U. S. SUPREME COURT AND PUBLIC UTILITY VALUATION

By John B. Gest, Attorney, Philadelphia, Pa.

(Reprinted from "Engineers and Engineering," journal of the Engineers' Club of Philadelphia, for February, 1927.)

There are few intellectual wildernesses so trampled by pathless wanderers as the so-called field of public utility regulation. Here the engineer, the lawyer, the economist and the financier are free to roam. Each believes the blazing of the trail rests with him and each is apt to go his own way, or perhaps in many cases the wayfarer cares little for marking a trail but is rather in search of private gain. Whatever the motives it is unlikely that such different travellers would follow the same course or that all would be headed in the same direction.

A big man's intellect will often outstrip his early education, and the little fences between engineering, legal and commercial thought are often passed as advance is made in any profession. But still such problems as public utility regulation are apt to be viewed from a professionalistic standpoint.

For example, the question of the deduction of depreciation from the rate base means to the case hardened lawyer a study of what courts have done in decided cases. An engineer will probably address himself to a survey of the physical property of the utility in order to form a conclusion as to the deleterious effects of wear and tear, the elements, and the neglect of repairs and renewals. The accountant may view the problem as one dependent upon the system of keeping books, and the term "depreciation" as conceived in his mind is rather a paper liability than a physical fact. The financier will probably be interested in the protection of the investment and the past, present and future return to the owners. It is small wonder then that the Supreme Court has delayed the formulation of a rule for fixing value for rate making purposes, and has contented itself with stating only in very general terms the matters which must be considered in determining value.

The Supreme Court was not obliged to consider the factors entering into the rate base prior to 1898. In the cases before that date in which it held rates to be so low as to confiscate property, in violation of the Constitution of the United States, the rates were insufficient to meet operating expenses. But the day could not be postponed and a consideration of what constitutes fair value was precipitated in Smyth v. Ames.[1] Here stockholders in the Union Pacific, Chicago and North Western, and C. B. & Q. were protesting against rates fixed by a statute of Nebraska. William Jennings Bryan argued for the State and we may imagine with what force the eloquent champion of the people's rights argued that the court had no right to pass on the reasonableness of the profit remaining to the stockholders after paying operating expenses, but that in case it had this right then "the present value of the roads, as measured by the cost of reproduction, is the basis upon which profit should be computed." Whether or not it was a reflection of the brilliance of the orator's argument, or of the innate soundness of the rule, the court decided that a fair return must be allowed on the fair value of the property, and that in determining value for rate making purposes various factors must be considered, including the original cost, and "the present as compared with the original cost of construction."

The court mentioned other matters to be considered, but after removal of dunnage and spare parts the rule of this case is broadly that both original cost or investment,[2] and cost of reproduction were to be considered in fixing value.

Needless to say, in that case cost of reproduction was less than investment. Now the tables have turned. They had turned to some extent in the Minnesota rate case[3] where Justice Hughes said "It is clear that in ascertaining the present value we are not limited to the consideration of the amount of the actual investment. If that has been reckless or improvident, losses may be sustained which the community does not underwrite. As the company may not be protected in its actual investment, if the value of its property be plainly less, so the making of a just return for the use of the property involves the recognition of its fair value if it be more than its cost." Like all good rules (and some others), the rule of Smyth v. Ames works both ways, and reproduction cost was thereafter to be considered in de-

[1] 169 U. S. 466.

[2] This discussion is not concerned with differences between original cost and investment due to reinvested earnings, or to irregular handling of capital, etc.; nor with the various theories of depreciation.

[3] 230 U. S. 352, 1912.

termining value in cases where it is higher than investment as well as when lower. Thus the argument which first appeared against the utilities was adopted by them, and undoubtedly saved some from disaster in the period of inflated prices following the war when expansion was vital and a cost of reproduction rate base was necessary in order to attract capital.

It is not the purpose of this article to pass judgment on the many interesting arguments for or against cost of reproduction. The reflection of all the numerous arguments on both sides can indeed be found in the mystic maze of Commission and Court decisions but the Supreme Court of the United States has not departed from the rule of Smyth v. Ames, nor has there been a crystallization of any definite rule as to the relative weight to be assigned the different elements of value to be considered. This is clear upon a glance at some of that Court's most recent decisions.

In Missouri ex rel Southwestern Bell Telephone Co. v. Public Service Commission, decided May 21, 1923, the Public Service Commission of Missouri had valued the telephone properties in the state, as of 1919, by adding the cost of subsequent additions to previous valuations made by the Commission in 1913, 1914 and 1916. This, of course, took no account of the increase in costs between such dates and 1919, which amounted to about 50 per cent. Mr. Justice McReynolds, who wrote the opinion reversing the action of the Commission, epitomizes the theory of the court in the neat aphorism "Estimates for tomorrow cannot ignore prices for today."

Sometimes it is thought that the publication of dissenting opinions jeopardizes the prestige of the Court—but there is something intensely American, or Anglo Saxon, or Nordic, or some other adjective that means that you and I are better than the rest of mankind, in the triumphant defiance of our minority judges, who are "down but never out." And, too, very valuable contributions to legal science, if such a thing is extant, are often made in the form of dissenting opinions.

Mr. Justice Brandeis wrote a concurring dissent in the Southwestern Bell case in which he was joined by Mr. Justice Holmes. This means that the judge goes to the same place as the Court but by a different route. Brandeis' opinion is a masterful writing on the subject of valuation, and the reading of it is well worth even an expert witness' time. His theory that "prudent" investment should be adopted as the rate base is not the law—in fact its universal adoption now would work injustice in many cases of old utilities—but his reasoning is entitled to study, and his statement that "The so-called rule of Smyth v. Ames is, in my opinion, legally and economically unsound" may be echoed in some majority opinion in the future.

Within three weeks of this decision the Supreme Court in Bluefield Waterworks and Improvement Company v. Public Service Commission[4] reversed a decision of the West Virginia Commission which had used previous valuations of 1915 brought to date of 1920 by adding capital additions at cost. The report of the commission in the 1915 case showed clearly that investment was used as the rate base in that case, and the Supreme Court in an opinion by Mr. Justice Butler found that "the commission, in arriving at its final figure, did not accord proper if any weight to the greatly enhanced costs of construction in 1920 over those prevailing about 1915, and before the war——." This decision harmonizes with the Southwestern Bell case and cites Smyth v. Ames with approval.

The Atlanta Gas case, Georgia Railway and Power Company v. R. R. Commission of Georgia,[5] was decided on the same day as the Bluefield case and served to correct the impression that the Supreme Court had approved "slavish adherence to cost of reproduction, less depreciation"[6] in fixing the rate base. Here the Commission in 1921 valued so much of the property as was in existence January 1, 1914 (most of the plant), at substantially its actual cost. Construction costs were about 70 percent higher in 1921 than in 1914, and the Company claimed that the property should have been valued at the cost of reproduction prices. It appears that the only "unearned increment" allowed in fixing value was an appreciation of $125,000 in the value of land. The value fixed by the Commission was $5,250,000. The Company claimed $9,500,000 on cost of reproduction basis.

Mr. Justice Brandeis, having shot his

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[4] 262 U. S. 679.
[5] 262 U. S. 625.
[6] Language used by lower court quoted by the Supreme Court.

bolt on prudent investment in the previous case, wrote the majority opinion on the Smyth v. Ames theory, and supported the decision of the Commission, saying "The case is unlike Missouri ex rel Southwestern Bell Telephone Company v. Public Service Commission. Here the Commission gave careful consideration to the cost of reproduction, but it refused to adopt reproduction cost as the measure of value. * * * The refusal of the commission and of the lower court to hold that for rate making purposes, the physical properties of a utility must be valued at the replacement cost, less depreciation, was clearly correct."

Mr. Justice McKenna dissented believing this decision to conflict with the two preceding cases. Certainly this is a subject on which not every man, no not every judge, is presumed to know the law. Will a statement by the commission that it carefully considered reproduction cost be sufficient? Or does the allowance of appreciation in land value show sufficient consideration? Or was Justice McKenna right? In answering these questions there is this to be kept in mind. In the first two cases there had been previous commission valuations. Since those valuations must depend on a consideration of cost of reproduction, any change in this factor should change the valuations; and if the previous valuations stand unchanged except by the addition of new capital expenditures it follows that the upward swing in cost of reproduction was not considered. In the third case it was an original valuation and it was apparently felt by the majority court that sufficient consideration of cost of reproduction was shown in the allowance of land values. If this was the theory it is probably reconcilable with McCardle v. Indianapolis Water Company, decided November 22, 1926.[7]

In the latter case the Indiana Public Service Commission had fixed rates for the Indianapolis Water Company by order effective January 1, 1924, reporting the value of the operative property of the company to be $15,260,400. This was based on a previous valuation as of December 31, 1921, brought to date by adding subsequent capital additions at cost. The previous valuation adopted outright cost of reproduction less depreciation at average prices over a period of ten years ending December 31, 1921. The lowest estimate of "spot" price cost of reproduction less depreciation as of January 1, 1924, was $19,500,000, without, however, including water rights and going value which brought it to over $21,000,000.

The District Court granted an injunction against enforcement of the Commission's rates. The district judge seemed to feel obliged under the three cases discussed above to adopt "spot" price reproduction cost less depreciation as the rate base, and found the value to be not less than $19,000,000, which figure he believed represented the lowest possible estimate at spot prices.

The Supreme Court in an opinion by Mr. Justice Butler, with Mr. Justice Brandeis again dissenting, and Mr. Justice Stone with him (not, however, on the prudent investment theory) affirmed the District Court decision and found the value to be not less than $19,000,000 without, however, approving the reasoning suggested in the language of the district judge. It declared that "While some expressions of the district judge indicate that he was of opinion that dominant or controlling weight should be given to cost of reproduction less depreciation estimated on spot prices as of January 1, 1924, it is clear that the $19,000,000 fixed by him as the minimum value could not have been arrived at on that basis." It is then shown that the minimum figure at spot prices after inclusion of water rights and going value was $21,051,000 and that the company's estimates were considerably higher. And the court reaffirms the Smyth v. Ames rule, saying, "The decision of this court in Smyth v. Ames declares that to ascertain value 'the present as compared with the original cost of construction' are, among other things, matters for consideration. But this does not mean that the original cost or the present cost or some figure arbitrarily chosen between these two is to be taken as the measure. The weight to be given to such cost figures and other items or classes of evidence is to be determined in the light of the facts of the case in hand."

The valuation previously made in 1921 on ten-year average prices had been used as the rate base, except for adding new property and some minor changes. The Supreme Court said: "The high level of prices and wages prevailing in 1922 and 1923 should be taken into account in finding value as of January 1, 1924, and the years immediately following." This case is substantially in harmony with

[7] 47 Sup. Ct. 144.

the Southwestern Bell and Bluefield decisions, although it goes farther in making a definite finding of the effect of increased prices on the rate basis. The trained ear, however, distinguishes a note of discord when this case and the Atlanta Gas case are sounded together, unless indeed they can be reconciled on the ground that one is based on a former valuation, the other on a new one.

It has not been attempted in this short discussion to wade through the eddying current of Court and Commission cases, but to pass lightly over the stepping stones laid by the Supreme Court, for it is that body which must eventually choose the best of legal, engineering, and financial thought and formulate more definite rules. The tremendous post-war spread between cost of reproduction and investment in our established utilities has been prolific of much confusion and litigation. "Gentlemen may cry peace, peace—but there is no peace," as long as utilities and public can sincerely advance such widely differing measures of value as the rule of Smyth v. Ames allows. There is no peace as long as the law appears to require fixing a rate base before determining fair return, when justice often requires first considering the capital structure of the utility, the amount of interest and discount on its indebtedness, and the past history of its depreciation and dividend accounts—and their going into reverse to find fair value.

The prospect for clarifying the law, however, is bright. Many utilities having ridden over the crest of the recent wave of prices on the reproduction cost theory, are abandoning it, faced as they are with the prospect of being swamped in the trough of the wave, if that theory should become too firmly fixed and a further decline in prices should follow. And undoubtedly, as expansion in the utility industry takes place at post-war prices, investment and reproduction cost figures will, in many cases, more and more approach each other, accounts will be available, and the laborious estimates of cost of reproduction will pass out of the picture. This will mean not only the saving of time and expense of litigation, but the releasing for productive work of a wealth of the intellectual resources of the utilities. And our professional explorers can join forces and cut their way through the thicket to the discovery of a more definite rule for finding value fair to all parties.

TESTING AND THAWING FROZEN CONCRETE

By A. M. Bouillon, in The American Contractor.

Because of the extensive winter work now being done, it may not be amiss to describe the phenomena attending the attack of frost on concrete and how these effects may be ascertained and counteracted. Practically every winter during recent years has had its toll of construction failures due to improper protection against frost, unfortunately backed by overconfidence in the heating arrangement provided, or by inexperience.

It is probable that most of these construction failures could have been prevented, even after the concrete had frozen, if a careful examination and testing of the concrete had been made prior to the removal of the forms and bracing.

Watch Outside of Walls

Such building failures due to frost action are often the result of lack of proper heating provisions on the outside of the outer walls. These may have been covered with tarpaulins and some provision made by openings for circulation of the warm air from within. Such so-called protection is not only inadequate against the effect of severe cold, or even mildly cold winds, but is a contradiction of sound construction tactics, for it must be evident that concrete walls require the same heating protection on both sides. The outer face being most exposed should be the one that is most protected. The greatest danger from freezing comes with the high cold winds and blizzards. The affect of such is to penetrate through improperly fastened housing or tarpaulin protection and drive out the heat, substituting therefor the temperature of the outside air which might be many degrees below freezing point and forcing it against the forms. Thus, it is very essential that proper insurance against the most inclement weather typical of the locality be provided. This means taking no chances. The actual difference in the cost between uncertain and adequate protection is slight. The importance of the risk, its possible result in loss of life, financial loss and loss of reputation, should dictate absolute safety always.

Wet Mixture Is Least Affected

The effect of frost on freshly made

concrete causes the water to expand and to develop minute disunion of the concrete, the energy of the forcible separation being proportionate to the quantity of water in the mixture and to the degree of setting already acquired when the freezing effect overcomes the progressive course of hydrolisis.

The result of investigations shows that wet concrete in freezing expands more than dry concrete, but that less damage results to wet than to dry mixtures when thawed and allowed to set and harden. It is evident that the greater plasticity of wet mixtures enables them to contract when thawed and return to practically their original displacement. This is not the case with dry mixture which, after thawing, will retain a certain percentage of the expansion and porosity acquired through the mechanical action of frost. Dry mixtures when thawing will not automatically reunite nor consolidate compactly, unless vigorously tamped, which treatment, however, would in many instances prove injurious to the concrete, particularly if reinforced, and is not recommended.

Water-Cement Ratio Based on Mild Weather

The experiments which have led to the adoption of the water-cement ratio as the determining strength factor in the mixing of concrete were based upon mild weather construction conditions. The heating of aggregates and of water used in concrete, which are necessary requirements of construction carried on in freezing weather, incite quicker and more prolific evaporation than would occur under ordinary conditions. In mixtures containing the right amount of water required to obtain a high concrete strength there is always the danger that overheating of the aggregates, which at times may occur even in the best regulating heating plants, will result in the evaporation of water in the mixture to such an extent as to reduce the strength of concrete quite materially, because, while heat will hasten the process of hydration, the evaporation that takes place in overheated mixtures goes on at a much faster rate than the setting. In fact, the writer knows of quite a few cases where the hardening process was stopped by the drying action caused by loss of moisture from dry mixtures, this condition resulting in concrete far below the strength it should have acquired.

Evaporation May Be Excessive

The loss of moisture caused by the abnormal evaporation due to overheating and also caused by the slow but long extended evaporation that takes place in frozen concrete or in concrete not frozen but so cold as to retard hydration, saps the vitality of dry mixtures but has no particular effect upon mixtures that contain a slight excess of water because the losses due to evaporation of whatever source are replenished by the excess water contained in the mass. It is therefore evident that practical requirements of winter construction demand a slight increase in the amount of water actually required and it might also be added that similar laws likewise apply to concrete built in hot weather where the aggregates and placed concrete may be exposed to the hot sun, particularly in hot and dry districts, as in the semi-arid regions of our western states. This necessary increase, intended to compensate for expected ultimate evaporation, may vary according to conditions, but on the average will amount to about ten per cent. As a further insurance, all concrete should be given the moisture, or curing, treatment, beginning 18 to 24 hours after placing. The great importance of this requirement is fast being recognized and the writer expects that this item will soon be given a prominent place in all concrete specifications and inspectors instructed to insist that such be enforced.

It has been demonstrated by tests that no serious ultimate harm results to ordinary plastic portland cement concrete mixtures that have been frozen, thawed and then properly protected against further frost action and allowed to harden, particularly if such treatment is followed by proper curing measures. Freezing seriously affects concrete made with some of the natural cements. As this material is now rarely used in this country and Canada, the effect of frost on concrete made with it will not be discussed in this article.

Of course, the uncertain elements that may become active drawbacks, productive of ultimate financial loss, emphasize the necessity to prevent the freezing of portland cement concrete. However, the too frequent and, in certain instances, very serious failures that have happened to structures supposed to have properly hardened but that have collapsed due to having been frozen, indicate the need of

education as to how to discover and how to restore frozen concrete.

Below 35° F. Stops Chemical Activity

The cooling of freshly made concrete results in deceleration of the coalescing activity of the cement in the moisture, particularly along the face of the forms that are most exposed to the outside cold. As the cooling intensifies, this chemical action is eventually checked so that when the temperature reaches around 35 deg. Fahrenheit the process of hydrolysis has reached a standstill. Unprotected or insufficiently heated thin reinforced concrete walls, roofs, etc., are extremely susceptible to frost, their thinness making it possible for the frost to penetrate throughout quite rapidly once it has attained a grip on the exposed side. The inroad of frost action upon concrete placed in mass or in large bulk, such as concrete piers, abutments, dams, etc., is not at first seriously felt within the interior of the mass, because of the fact that the internal heat that is developed through the chemical process of hydration will, particularly if acting in combination with heating of the water and aggregates, counteract the incursion of frost until this resistance is nullified and overpowered by increasing frost activity. It is therefore possible in mass concrete to find set or partly set concrete incased in a more or less irregular shell, or spots, of frozen concrete, according to conditions of exposure and vulnerability of the protection.

Mechanics of Freezing and Thawing

The first freezing will cause numerous irregular and exceedingly thin fissures throughout the concrete mass which upon thawing will draw water from the adjoining margins. If the thawing is allowed to proceed and the concrete protected against further frost, these fissures will proceed to close, thus forcing the water back into the mass and restoring its previous equilibrium except in the case of too dry mixtures as previously noted. The excess water present in the case of too wet mixtures will be displaced by the heavier ingredients through the action of gravity and its bulk will ultimately be forced to the surface or through seams in the forms, as would have resulted if the concrete had not frozen.

If, instead of being protected and allowed to thaw out fully and set properly, the frozen concrete should thaw and then freeze again before the equilibrium of the mixture had been re-established, the effect of this second freezing would be to enlarge the fissures made by the first freezing and to supplement these by very thin radial cracks. If then allowed to thaw and to set, with proper protection against further freezing, plastic concrete that has been subjected to two series of alternate freezing and thawing will, according to investigations made by the writer, suffer a loss in strength of 20 to 30 per cent on the 28-day test and still greater loss for dry mixture. A continuation of the tests showed that up to half of this loss was regained on the six months test but this result was far from being uniform, therefore could not be depended upon.

Eventually Ensues Destruction

The effect of still further exposures to freezing with alternate thawing, as might occur during a series of cold nights and warm days, assuming that the thawing period is insufficient to develop any effective resistance through hydration, will eventually destroy the cohesive qualities and render this concrete inert. Tests showed that after the fourth exposure of plastic concrete to alternate freezing and thawing 50 to 70 per cent of the strength had been lost, dry mixtures being injured even more.

It is therefore obvious that while concrete of ordinary plastic mixtures can be restored to full strength after being exposed to one period of steady freezing without any intervals of thawing, this does not apply to concrete that has been subjected to alternate freezing and thawing. Frozen concrete can usually be detected by its color, but a peculiarity is that white frost indications may be entirely lacking from the face of frozen concrete.

Ways to Detect Frozen Concrete

The easiest and most certain method to determine this condition is by applying warm water or a mild flow of steam against the suspected spot. It is also possible to detect frozen concrete by holding the palm of the hand against the suspected surface for one or two minutes and noting the reaction. If the concrete is frozen the feeling will be icy and continue so no matter how long the hand is held there. All doubt should first be eliminated by thorough examination embracing the whole structure before any

portion of the forms or bracing is removed. The first step will be to cut small inspection openings in the forms, say three or four inches square, care being taken not to cut into the concrete. These openings should be so spaced and located as to allow of positive information to cover all of the concrete faces, but particularly those that have been most exposed to inclement weather. The warm water test, or mild steam pressure test, should then be applied over the exposed concrete. If frozen, the concrete will be thawed by this application, become soft and crumble easily. Make a record of the results of each test upon a small-scale drawing, or blue print plan or elevation, upon which the location of each inspection opening has been accurately shown. Close the openings flush against the concrete as before, taking care that there are no bad open joints through which the water to be used in curing may escape too freely.

Sprinkle With Water

The next step should be to tighten and strengthen the forms with additional bracing as will be manifested by the final result of the inspection, which will take into account the height and extent of the frozen concrete which when thawed out will bear pressure against the forms and also any tributary loading due to construction conditions. Coincident with this, there should be provided proper housing and heating to insure gradual thawing and subsequent complete hydration of the concrete. Having taken these protective measures the next step will be to either install ½ or ¾-in. pipes along the top edge of the forms perforated with tiny holes every foot or two that will provide a flow of water between the face of the concrete and the forms, or arrange for frequent sprinkling with either hose or buckets. This will provide much earlier thawing and setting, besides insuring the same greater ultimate strength that would be obtained through curing, this sprinkling, if prolonged sufficiently, providing both needs.

The thawing of frozen concrete requires care and good judgment. As far as it is practicable it should begin at the extreme bottom of the frozen section, which, if very high, or a building of several stories, should be extended upward very gradually not more than one story at a time. The water to aid in the thawing and insure curing will also prevent cracks or crazing and will be of special benefit in case the concrete placed was a strict water-ratio mixture designed for a certain strength without additional margin to counteract the evaporation that would take place either in the delayed hydration process retarded by frost action or in the accelerated hydration resulting from overheating of the aggregates.

If the above suggestions are carried out the restoration of frozen concrete can be accomplished at slight expense. The actual time required for thawing the concrete will vary according to the extent of the frozen area and its penetration, but usually it takes 24 to 48 hours to get the frost entirely out of a wall 10 to 15 in. thick and it may take two weeks to one month to thaw out a frozen pier 8 to 10 ft. thick. As warmth reaches the concrete it gradually resumes the setting and hardening process that was interrupted by the frost. This warmth must first penetrate through the forms and is greatly assisted by the flow of water previously recommended. Warm water in such instances is, of course, more active than cold water, but cold water is much better than no water. The forms should be kept on until perfectly assured that the frozen concrete has been fully restored, cured and hardened. It is the writer's opinion that the early removal of forms is sometimes carried to extremes without apparent reason. It is a practice that is particularly objectionable in winter when concrete in the early stages of hardening is exposed suddenly to a change of temperature that may reach 75 to 100 degrees or even more, at a time when its acquired resistance may be less than one-quarter of its ultimate strength. The effect of the sudden change causes uneven stresses, particularly active on the exposed faces, resulting in small cracks and certainly in a reduction of the ultimate strength unless this removal is compensated by continued curing protected by the housing and heating. The too early removal of forms in summer, particularly in hot, dry climates, has also resulted in failures of the structures due to rapid evaporation of the water in the concrete accelerated by exposure of the concrete to the hot sun, resulting in drying of the mass before hydration could fully take place.

CO-ORDINATION OF RAILWAY AND HIGHWAY SERVICE

By W. J. Cunningham, James J. Hill Professor of Transportation, Harvard University, Cambridge, Mass.

(From address before Society of Automotive Engineers, Nov. 17, 1926.)

At the present time there are registered in the United States about 20,000,000 motor vehicles, including about 70,000 buses and about 250,000,000 trucks. These represent an investment of approximately 18 billion dollars devoted to highway transportation. That investment has more than doubled since 1920.

The total investment in railroad equipment is about 6 billions. On that basis of comparison the investment in motor vehicles is now about three times as great as the investment in railroad motive power and rolling stock. The railroad investment in right of way, track and structures, stations, terminals, shops and other facilities is about 17 billions.

It is interesting to compare that amount with the total of public funds invested in improved highways, constructed, in the main, to meet the needs of the motor vehicle. There are something more than 3,000,000 miles of highways of all kinds. Of these there are now nearly 500,000 miles of hard-surfaced highways which, according to the estimate of the U. S. Bureau of Public Roads, cost about 8 billions of dollars.

It is evident, then, that at this stage of the highway development, the public investment in hard-surfaced roads alone is approximately one-half of the private investment in railroad physical structures outside of equipment.

$26,000,000,000 Invested in Motor Vehicles and Highways

If we combine the investments in motor vehicles and hard-surfaced highways, the total is 26 billions, or about 3 billions in excess of the total investment in railroads. At the present rate of growth in the production and use of motor vehicles, and the extension of improved roads, the excess of investment over railroads will grow rapidly larger year by year, when note is taken of the fact that the highway construction recently has been on a scale in excess of one billion dollars annually, a sum greater than the railroads are expending annually in additions and betterments. Today's cost of a modern concrete highway is approximately equal to the average per mile cost of existing railroads, including equipment and terminals.

We are here comparing a well defined class of public service by railroads with a loosely defined combination of automobiles, buses and trucks, some engaged in public service and some used in private business or for pleasure. It is impossible to make the separation between commercial motor vehicle mileage as a means of profit or as an adjunct to private business, and mileage made for purely social use and pleasure. These difficulties are embarrassing when we attempt to measure the relative transportation production of the highway and the railroad. Moreover while we have exact knowledge of the transportation output of railroads we are without such data for motor vehicles and are thus forced to use estimates which require many assumptions.

There is too great a tendency, however, to predict that in the not distant future the railroads are doomed to take but a minor place in transportation as highways are further extended and improved and as the motor vehicles increases in number and effectiveness. Such a prediction runs counter to economic facts. In the long run that form of transportation will survive which for the service rendered has the lowest economic cost. The great bulk of freight transportation in this country is in mass movement long distances. In that field the railroad is economically supreme. Likewise in passenger transportation, the railroads will continue to take care of the long journey passenger, the overnight traffic between large cities, and the mass movements of suburban passengers morning and evening.

Taking up first the question of freight service, it appears that here the railroads have less to worry about, and the public generally has less direct interest than in passenger service. Nearly three-quarters of railroad operating revenue is derived from the freight service. Relatively little of it is of a class or within a zone which admits of serious encroachment by truck. Yet while relatively the competitive tonnage is small, the amount is large when stated in absolute totals.

The Field for Motor Trucks

When we remember that the number of motor trucks now in use is slightly greater than the total number of railroad freight cars, the potentiality is evident, even when account is taken of the fact that something like one-half of the

trucks operate almost entirely within metropolitan areas and a substantial part of the other one-half is used in rural service non-competitive with railroads. That part of the truck-borne tonnage which was railroad-carried before the advent of trucks is confined mainly to shorthaul less than carload traffic between cities in the highly developed industrial zones.

Here the superiority of the truck for the movement of high grade manufactured products and certain kinds of raw materials in limited quantities is unquestioned. In most cases where trucks are used the inclusive ton-mile cost is lower than the combined cost of rail movement and trucking between the rails and the plant or warehouse, but even where the ton-mile cost of all-railway movement is slightly higher than by rail, the savings in the typical case in time, in packing, in loss and damage, and in the better control of movement, favor the motor trucks.

The railroads are not in ignorance of these facts and while it goes against the grain of the railroad traffic manager to lose tonnage which was once his, the loss is accepted with an approach to equanimity, if not by the traffic department, at least by the operating department.

That short-haul traffic, particularly in less than carload lots, adds substantially to gross but contributes little to net revenue. Indeed, in many cases, it is not remunerative when charged with a fair proportion of indirect expenses and charges. Where facilities are taxed to the limit by freight of all classes, the short-haul, low net-producing traffic interferes with and slows up the movement of the better-paying long-haul tonnage, and in many cases the net result would be more favorable if the overburdened facilities were relieved in the interest of freer movement of the more desirable traffic and more rapid turnover of equipment.

So far as terminal expense is concerned, the cost of handling the short-haul is the same as that of handling the long-haul ton. Under the existing rate scale it may be demonstrated that in many cases the element of terminal cost, as distinguished from the element of line-haul cost, is not adequately recognized in the charge to the shipper, hence as a general rule, even though there are frequent exceptions, the longer the line haul the greater the profit.

Railroads Supreme in Long Haul Traffic

If the typical railroad were fully equipped to handle expeditiously and economically all of the tonnage in sight, the force of what has just been said would be diminished, as under the economic law of increasing returns every additional ton is worth taking if it pays even a very small excess over the direct expenses of terminal and line handling, exclusive of indirect and constant expenses and charges which must be met by the traffic as a whole. The important limitation of that economic law is that it applies only when there is unused capacity. It does not operate when the facilities are utilized to the economical limit. Beyond that point the law of decreasing returns operates until facilities are expanded.

But if the railroad traffic manager, in spite of these economic facts, is worried by the diversion of local freight to the highway, he may be comforted by the fact that the automotive industry adds to his total tonnage much more in good-paying business than the trucks take in poor-paying tonnage. It is estimated that in 1925 the railroads carried over 3,000,000 cars loaded with motor vehicles or materials used in the industry. This takes no account of material used for highway construction. It is probable that both classes of traffic made up one-eighth of total railroad traffic in 1925.

There is, of course, the difficult question of determining the critical point in length of haul, the distance within which the truck is economically preferable and beyond which the railroad is the better agency. I do not think that it is practicable to set a definite limit at this time. The distance will vary with local conditions, including the character of the highways, the capacity of existing railroads, the volume of traffic and the nature of the commodities. In some cases it may be 30 miles; in others it may be 50 miles. The answer may be found only by intensive study of the specific locality. Recent surveys of highway traffic have some significance in their indication that about 80 per cent of the trucks are operating within a zone of less than 30 miles.

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Transportation Co-Ordination

A sound policy of transportation coordination would seem to dictate that the railroads instead of looking upon the motor truck as a harmful competitor, and

obstructing its wider use, should recognize it as a desirable means of relief from the responsibility of providing freight house and other terminal facilities for that traffic which is most burdensome from the viewpoint of operation and car utilization and least desirable from the viewpoint of net revenue. I believe that this opinion is now held by the majority of railroad executives who prefer to have their facilities more fully used for tonnage which moves in solid trains over each engine district.

A further element in a program of co-ordination is that of utilizing the motor truck directly by the railroads or under contract for the railroads, as substitutes for the expensive and facility consuming way freight train. Several roads are now so using motor trucks on the highways and the results are promising in two fields, (1) in and near large terminals in metropolitan areas and (2) as a substitute for local freight trains on thin-traffic branch lines.

Another phase of co-ordination is the creation of new traffic by motor trucks. It is probable that for every ton of local freight taken from the railroads by motor trucks, more than one ton of new traffic has been brought to the railroad by trucks which have developed new producing territories so remote from the railroad stations that the heretofore existing forms of transportation were prohibitive in cost. This is a field wherein the industrial departments of railroads may increase railroad revenue by co-ordination with trucks.

Store-Door Delivery and Containers

Two other phases of co-ordination may be referred to very briefly. Their importance justifies much more time for discussion than is now available. I refer to the service of door-to-door delivery, commonly termed store-door delivery, and the use of unit containers. Largely because of differences in opinion concerning a few factors of relatively minor importance, the railroads and the shipping interests have not yet made the progress that should have been made in adopting door-to-door delivery and thereby effecting desirable economies in time, freight house capacity, freight car utilization, and demand upon crowded city streets. Its adoption in some form is bound to come ultimately. The principle, I believe, is economically sound and in broad public interest. In a somewhat limited field the unit container has distinct economic advantages and its use is likely to be broadened.

What About Railroad Passenger Traffic

So much for the freight service. When we turn to the passenger service we find that the motor vehicle has made serious inroads on railroad passenger revenue. While the railroad freight traffic as a whole has been increasing, in spite of the development of motor trucks, the railroad passenger traffic has been declining in total.

In the five years from 1920, after demobilization of the army had practically been completed, to 1925, the number of railroad passenger shows a loss of nearly 30 per cent, and the number of passenger miles shows a decrease of 23 per cent. An increase of 6 per cent in the average journey accounts for the fact that the decrease in the aggregate passenger miles was less than the decrease in the number of passengers, and indicates the nature of the loss. It is in short-distance local passengers. It is not in long-distance riders. Their number and their aggregate mileage has increased, particularly in Pullman car riders, notwithstanding the much complained of Pullman surcharge. It is not in the commutation or suburban passengers. They also have increased slightly in number. The loss to the railroads is confined to the local passenger trains between adjacent cities and in rural districts where the private automobile and the motor bus are affording more convenient and more frequent service.

As between the private automobile and the bus, the former has taken by far the greater number from the railroads. The bus as a factor in the situation was not important three or four years ago when the recession in railroad passenger traffic had already set in unmistakably. The bus, of course, has accentuated the loss, and inasmuch as the buses are steadily increasing in number, their effect in the immediate future may be seen in further inroads on railroad local passenger traffic.

While the number of long distance automobile riders and tin can tourists is absolutely large, and while we cannot but be impressed by the number of states represented by the registration plates on cars which we meet in the tourists season on any of the trunk highways, but a small part of that traffic is really competitive with railroads. In the main, it is traffic which the automobile itself created and would not have gone to rail-

roads if the motor vehicle had not been developed. To be sure many a summer vacation trip heretofore made by rail is now made on the highway and a large part of the thirsty tourists who now choke the trunk roads to Montreal might pay railroad fare if there were no other way to make a personal inspection of the workings of the Quebec system, nevertheless, as has already been stated, the through passenger trains are not losing in patronage and the railroads need not be greatly concerned over that form of competition.

When the Automobile Competes With the Railway

The kind of competition to which they are harmfully subjected is that which can be illustrated by my own experience. I am fortunate enough to own a summer home in the White Mountain district of New Hampshire. We are 125 miles from Boston. During our first summers in that beautiful region we patronized the Boston & Maine R. R. but during the past four or five years, although the trips per season averaged from eight to twelve, I can recall using the train but twice and on each of those two occasions my journey took me beyond Boston by rail.

The highways are hard-surfaced to within 10 miles of my destination. Allowing for the time taken by the street car and subway ride to the North Station and the stage from the railroad to my summer home, I can, without reckless driving, make better time than via rail, I can go at any hour in comfort equal to that of a parlor car, and my total inclusive cost per mile, using a car in the $2,000 class, including interest, depreciation, insurance and taxes, is little more than the railroad fare for two passengers.

Unlike the smaller loss in local freight traffic, this diversion of local passenger traffic from railroad revenues is serious because the long distance travelers are not increasing sufficiently in number to make up the deficiency.

To meet its obligations as a common carrier the railroad must run at least the minimum of passenger service and its schedules are subject to review by the state regulating authorities. The citizen who is not a car owner or who prefers to use the rails rather than the highway must be provided for. As a result the typical railroad, particularly in New England, on its many lines of thin traffic, is running passenger trains which do not pay all of their direct expenses, to say nothing of a fair proportion of indirect expenses, taxes and interest charges. If the railroad is to remain solvent, the loss must be borne by long distance passengers and shippers by freight. No part of the loss can be transferred to the commutation passenger although, in the typical case, he is now carried at rates which are not remunerative.

It is easy to understand why the railroads desire to abandon those lines in which the greatest loss is sustained from operation. Except in but relatively few instances, however, such abandonment is contrary to public convenience and necessity and will not be permitted by the state and federal authorities. Even if passenger service were abandoned there would still remain the obligation of the railroad as a common carrier to perform the freight service. The existing bus lines do not as a rule serve every railroad-served community and in freight service there is even less organization of common carrier trucks to care for freight. In New England, as well as in other northern climates, many of the rural highways are impassable for motor vehicles during a part of the winter. Hence the reluctance of the regulating authorities to be swayed by a doleful exhibit of railroad red figures.

Replacement of Trains by Buses

At this stage of the development there appear to be but two alternatives. The railroads may either continue their unprofitable local passenger trains, cutting down the number of trains to the lowest limit permitted by the commissions, economizing in every practicable way, and attempting to make up the loss elsewhere, or they can go into the bus business themselves, attempting to regain a part of their lost passengers. If their bus service is comprehensive and reasonably serves every community on the local line, and if arrangements can be made with the state and municipal authorities to keep the highways clear of snow (assuming of course that the roads are hard-surfaced) the commission is likely in such cases to authorize the withdrawal of all passenger trains.

There would then remain only the question of freight. The railroad way and structures would still require maintenance, the burden of indirect expenses and interest charges would not be light-

ened, but the direct loss from passenger trains would be avoided and the red figure would be smaller. The direct cost of a local passenger train is about $1.25 per mile. The total cost of a bus is about 25 cents per mile. Even if the bus did not pay, there would be a substantial reduction in loss. Looking further ahead there appears to be no reason why, with hard-surfaced roads and the use of highway snow plows, trucks cannot be made to serve instead of the local freight trains, and the non-paying railroad lines completely abandoned.

Railroad-Operated Buses

That views similar to these are now held by many railroad executives is evidenced by the recent activities of railroads in inaugurating bus service either to supplement or supplant rail passenger service. You are all familiar with what has happened in New England. Here both the New Haven and the Boston & Maine Systems, through subsidiary bus companies are operating bus lines which parallel nearly one-half of their railroad lines. Complete financial results are not publicly available and I cannot say whether or not the lines actually show a profit. While it is yet too early to form any definite conclusions as to the actual degree of profit or loss, I believe that the action is along sound lines. The co-ordination of highway and rail service in public interest may best be accomplished by a greater degree of railroad participation in motor bus operation. In my opinion there is likely to be a substantial growth in that field. With the spectacular growth of the new form of transportation it is quite natural to find that the railroads, in their full growth of maturity, should be several laps behind motor vehicles in adapting themselves to new conditions, and the process of catching up with the procession is still going on. The earlier railroad attitude of obstructing the use of motor vehicles may now be regarded as shortsighted. They lost a great opportunity to be the pioneers in that field, anticipating the now well established public preference, under favoring conditions, for motor transport, instead of being forced into it late in the day primarily by motives of self protection. The processes of co-ordination, therefore, have been operating only during the past three or four years. The possibilities are difficult to measure and forecast; the economically desirable limits are difficult to define.

UNTYING THE TRAFFIC KNOT

By Col. Sidney D. Waldron, Member Executive Committee, American Automobile Association.

In no phase of our present complex mode of living is the maxim, "One-half of success is the possession of a good plan," more true than in relation to the growth of our larger cities.

When four farmers build their homes about a cross-roads the need of a plan begins, and it continues to assert its own necessity while the hamlet grows into a village, the village into a town, the town into a city and the city into a great city. Without a plan, growth is haphazard and misfit, and time is an implacable adversary, continually making more difficult the correction of the mistakes and omissions of the past. Ultimately almost unbelievable expedients must be resorted to when generations later all else has been changed, but the cross-roads standards of highway width.

The present century has ushered in the motor car, and with it a universal interest in good roads. This combination has so greatly increased the radius of action of the individual as to give time and distance entirely new values. In the past every small municipality was hemmed in for months at a time by a Chinese wall of mud roads. It was inaccessible to other centers, and its traffic problems were almost wholly of its own making. In 25 years this isolation has been banished forever. Ribbons of concrete connect city with city, and make the street system of each available to the other all the year around. Instead of a great number of independent municipal units, each more or less isolated from the rest, we are today, as a nation, approaching the status of a single, far-flung municipality.

Today no community can afford to consider its situation as separate and distinct from the communities with which it is linked by trunk line highways. No longer is its traffic only that which it makes. The automobile and good roads have multiplied the travel ability of the average family by at least ten, and there are enough automobiles in any one of the states to put the entire population of that state on wheels at one time and to move it out of the state, or into any one section. This new mobility is what links each municipality with every other, and makes them all together seem like a single city of slightly separated elements. This new mobility is what floods the

streets of a remote hamlet with the traffic of a great city. It is the prime cause for regional planning, because the interest of all of the people is greater than that of any individual or minor group.

We have passed the point where hard surfaced roads alone are sufficient in the densely populated states. We must provide wider rights of way along our strategically important arteries, than have ever been considered necessary in the past. Without going into detail I will briefly cite some of the facts upon which this statement is based.

1—The motor car is *a large user of road space* per average passenger carried.

2—The automobile is *rapid transit on rubber tires* for the individual. A single machine may bridge a 30-mile gap in an hour, and it may be part of the congestion at a dozen different points within the same time. Being a distance vehicle it requires improved through routes of adequate capacity for free and safe travel.

3—*Use* of the automobile as distinguished from ownership is increasing with increase in improved street and highway facilities. Facilities for safe travel create travel where none previously existed.

4—*Ownership* of the automobile is also increasing year by year.

In California the ratio of population to motor vehicle registrations is approximately three persons per car. In Iowa, Oregon, Nevada, South Dakota, Kansas, Nebraska, Florida, Colorado, Michigan, Indiana and Minnesota, we have an average of between 4 and 4.8 persons per car. The tendency in all states is toward an increase in ownership. Last year, South Carolina was at the bottom of the list with 4.2 per cent, while Florida topped the list with a registration increase of 47 per cent. The average for the whole country was 13.4 per cent.

The increase in number of vehicles is greatest in those states that already have the greatest total registrations. Thus, New York State, with 1,625,000 registrations last year, led all of the states with a numerical increase of 212,000 over the previous year.

And now, for the purpose of additional argument in favor of Regional Planning, I will draw a picture of the easily possible development in the growth of population and motor vehicle ownership during just a few decades ahead.

In 1920 the population of this country was 105 millions. During the past century our growth increased from two millions per decade to 13 millions. For the past 30 years we have been increasing at the rate of 13 to 15 millions each ten-year census. If we do not increase in population at any greater rate than approximately 15 millions per decade, then during the next 70 years we will add another 105 millions. Figuratively speaking, we will create another United States, and superimpose it upon the one in which we now live.

Whether we reach the total of 210 millions in 70 or 80 or 100 years is not the point I am trying to make, as much as the inevitable increase and the opportunities and necessity for planning now to provide for it.

What will the new requirements for increased road space be just for the motor vehicles owned by the population increase of 15 millions each decade?

What will the motor vehicle registrations of this country be 70 years from now, if our population is in the neighborhood of 210 millions?

If the tendency toward increased ownership per unit of population continues, even at a decreasing rate, we may at least expect a ratio in the neighborhood of 4½ persons per car in the entire country. It may even be lower than this. Each 15 millions added to our population will also add at least 3 1/3 millions to our registrations, without taking into account the tendency toward a larger percentage of ownership among the rest of the people. On this same basis we may reasonably expect total motor vehicle registration of approximately 47 millions in 1990, or about 2 1/3 times the number running today.

In order to better visualize what this means, let us take the case of Illinois, with a 1920 population of 6½ millions, and 1¼ million motor vehicles last January. If this state maintains only the average present increase of population of the entire country, then in just 64 years from now you will have a population of 13 millions, with over 3 million motor vehicles.

What is Illinois doing today to provide for these infinitely greater requirements of tomorrow?

These several factors of large road space per passenger, greatly enlarged radius of travel, increasing use and increasing ownership of the automobile, when added to our steady increase in

population require a decision upon our part between these two alternatives:

(a) Either we must permit the gradual choking of our age-old cross-road standards, and see this new mobility of the people destroyed through constantly increasing street and highway congestion, or

(b) We must make new plans and adopt new standards especially to fit this new mobility made possible by the automobile and good roads, and put them into effect wherever the major trunk line traffic arteries are not yet hardened beyond any possibility of relief.

It is inconceivable to think that seeing thus clearly the tendencies in population, registration and traffic growth, we should sit idly by and make no move.

In Detroit, a century and a quarter ago, our forefathers laid down three main highways, each 200 feet wide, through what is now the center of the city. They also established 120-foot widths for right of way for thoroughfares of secondary importance. These wide arteries are of untold value to us today, and would not exist except for their forethought.

About 50 years ago other public spirited citizens with prophetic vision laid out our Grand Boulevard 150 feet wide, 11.4 miles long, through field and farm land around the outskirts of the city of that time. Now, Detroit's center of population has moved out to the boulevard, and the city is solidly built up for miles beyond. As a transportation facility it is beyond price, for under no stretch of the imagination can we conceive of such a magnificent main artery being carved through the densely built up city of today.

It is perfectly obvious that once an area has become solidly improved it becomes increasingly difficult and expensive to change. What requires a large amount of finance inside of the city may, however, be accomplished with only a little forethought and co-operation outside its limits. What is needed is a plan, carefully worked out, to serve all sections equally; in other words, a Master Plan. It should provide for properly coordinated facilities with sufficient capacity to meet present needs, and with ample margin for the future. With such a plan time becomes a most powerful ally instead of an implacable foe, and works every day in the year in the interest of the community.

Detroit, the counties of Wayne, Oakland and Macomb, and the contained municipalities have created and adopted such a Master Plan of Super Highways and Interior Thoroughfares.

Adoption by the three counties means that no plats for subdivisions are accepted that do not provide for dedications of right of way to the standards prescribed along the particular routes affected.

Like the mill of the gods this one provision is automatically and continuously grinding out the necessary widths of rights of way all over the metropolitan area. It is not only saving untold millions of dollars in future condemnation suits, but, through establishing a greater potential traffic capacity it is stimulating a more valuable development of the property served and is thereby increasing taxable assets.

In addition to this method of the Boards of Auditors, private property owners' associations are doing wonderful work along the Master Plan routes in which they are especially interested. Added to these influences are county and state highway commissions, and a new form of organization created under special act obtained for that purpose, known as Super Highway Commissions. The latter are created solely for the purpose of acquiring rights of way, the improvement of which rests with the road commissions as before.

While what has been said about the Master Plan applies particularly to large cities and their suburbs, in principle it is applicable to every village, town, city, county and state in this country. Potentially great cities with heavy motor vehicle registrations demand a network of 204-ft. super highway rights of way, while trunk line routes of major importance across the states should not be less than 120 ft. wide from one side of the right of way to the other fence.

A mile of 66-ft. right of way contains 8 acres of land, while a mile of 120-ft. right of way contains 14½ acres. The difference is 6½ acres per mile. Along one of our trunk line roads the average cost of land purchased at its assessed value, for widening the right of way, was $400 to $500 per mile, and fence replacing cost $700 per mile. The two amounts, together, only approximated 3 per cent of the average pavement cost. There was some additional expense for moving buildings. In our opinion it is economically unsound to invest large sums of money in hard surfaced roads in a right

of way of 66 ft. It should not be less than 120 ft.

In thinly settled states or sections where land is cheap, the right of way can be made 120 ft. just as well as any other width. In the snow belt the wide right of way may be the cheapest investment for dropping the drifts far enough from the traveled road surface so as to minimize the cost of snow removal. In thickly settled states the traffic will demand wide rights of way along all the important main arteries, and no opportunity should be lost to acquire them as early as possible.

In our opinion every village should adopt the standard of 120 ft. of right of way for the two thoroughfares that intersect at its business center, and should steadfastly work to acquire that width.

Paved roads invite and create traffic. Development and increased values follow. The pavement is widened to the limit of the right of way available, and the cycle is repeated. When final traffic saturation is reached the new buildings and land values resulting from the service given by the pavement will too often be an insurmountable barrier to further necessary relief.

The foundation of the whole structure is the width of right of way. The very first operation, therefore, and one that should precede or be coincident with the laying of the first improved road surface should be the acquisition of the necessary land to provide for successive widenings in keeping with the strategic importance of the route. A narrow pavement in a wide right of way may be increased at any time; but a narrow pavement in a narrow right of way through a congested district is well nigh hopeless.

Acquiring these rights of way will not happen of itself. It must be brought about through the preparation of a logical plan that will not only set up the necessary legislative foundation, but will effectively unite the active interest and support of all the officials best able to carry the plan through to a successful conclusion.

This is no time to spend in regrets for what was not done in the past. Forget the mistakes and omissions of yesterday, but keep constantly before you the fact that during the next 70 or 80 or more years we are going to add another 105 millions to the population of 1920. Remember that only through the adherence to a Master Plan can our growth be orderly and in proper relation to our growing needs. Sink your super highways as deeply as possible into the outskirts of great cities, and then work outwards. Remember that traffic, and with it development, goes where it is invited and stays where it is well treated. Remember that those sections will benefit most that contribute most to the success of the plan.

GARBAGE COLLECTION AND DISPOSAL IN MIDDLE WEST

By W. H. Carrigg, Superintendent of the Garbage Department, Sioux City, Iowa.

(From the "Nation's Health" for March, 1927.)

Following a detail investigation of garbage conditions in various Mid-west cities it is evident that several widely different methods are utilized for the collection and disposal of garbage and rubbish. Municipal and contract collection systems, the latter either between the municipality and the contractor or the householder and the contractor, are in most general use, although numerous variations of these systems may be found in many of the communities.

The municipal system is in operation in my own city, Sioux City, Iowa, with the various collectors owning, operating, and maintaining their own outfits, which are all horse-drawn wagons of four-yard capacity and covered with canvas tarapulins. The entire city, an area of approximately 47 square miles, having a population of 80,000, is covered twice each week, with three collections being made in the more congested districts.

Regulations for Removal

We require the householders to drain and wrap all garbage, providing them with separate containers for all rubbish, although the two are hauled separately. In localities where we have alleys we require that all garbage and rubbish containers be placed on the alley line, and in districts where there are no alleys we require that the receptacles be placed on the parking where they are easily accessible for our collectors. These containers are taken in when the contents have been removed by the collector. Certain days are specified for collections and they are made at about the same time so that the containers need not remain on the parking an undue period of time, making the streets appear unsightly.

In disposing of the garbage and rubbish, the latter and the ashes are used to make sanitary fills. This saves thousands of dollars for the taxpayers since the city would find it necessary to make frequent long hauls with dirt. The topography of our city generally facilitates our ash and rubbish problem in that there are numerous ravines and hollows where such material may be deposited.

The garbage is sold to a hog feeder who pays the city $250 per month. His hog feeding yard is centrally located and in this way we avoid long hauls. The longest haul is five miles, the average being two miles. While this method of disposal is not as sanitary as incineration, it is more economical and, by selling the garbage, proves lucrative as well. The vital facts that interest all of us, whether we are in charge of garbage department or merely taxpayers on the sidelines paying the bills are efficiency and net cost.

Appropriation of $50,000

Our department collects 7,000 tons of garbage and 18,000 tons of rubbish annually, keeping within an appropriation of $50,000, which includes the upkeep and operation of a small automobile, our only expense other than wages. This is less than 60c per capita, considering a credit of $3,000 secured from the sale of the garbage.

Investigation of Complaints

That the citizens of Sioux City approve of the collection may be gathered from the number of complaints received from April 1 to October 1, 1926. During this period, which is one of heavy collections, 76 complaints were received and investigated. Seventeen, or less than three a month, were found to be justifiable. The unjustified complaints of failure to collect were due to householders' negligence to comply with the rules and regulations governing garbage collections.

In comparing the cost and the method of operation with that of other Mid-west cities, let us begin with St. Louis, which has a municipal garbage collection system, the city owning all equipment. It does not collect rubbish or ashes, but its cost of garbage collection and disposal aboard a barge for hog feeding is $5.40 per ton. Kansas City, Missouri, has a contract system, the contractor receiving $7.45 per ton for collection and disposal for hog feed. The rubbish and ashes are collected by private individuals who make a direct charge to the householders for this service.

The contract system is also followed in Omaha, Nebraska. However, the contractor is not paid by the ton but by the month. He receives $4,500 per month for seven months and $9,000 per month for the other five months. Collections are made twice a week during the summer and once a week during the other seasons. Rubbish and ashes are handled in the same manner as in Kansas City.

Another Contract System

Sioux Falls, South Dakota, a city of 30,000 population, has an entirely different contract system. Sixteen private collectors contract with the individual householders for a sum of from $12 to $20 per year, depending upon the amount of refuse to be hauled. They collect all garbage, ashes, and rubbish, but the cost of collection for the entire city is approximately $100,000 per year.

A combination of the farmer-municipal collection system is found in St. Paul. Certain districts are assigned to a few small hog feeders, the balance of the city having municipal collection of garbage. The city owns its own equipment and disposes of the garbage it collects to various hog feeders. The collection cost is $4.68 per ton. All rubbish and ashes are collected as in Kansas City. Across the river, Minneapolis follows practically the same system except that the city collects all garbage in its own equipment, which is entirely motorized. No ashes or rubbish are collected other than by private haulers who make a direct charge to the people. Prior to the opening of the new incinerator, the collection cost including delivery at the old incinerator, was $5.78 per ton.

Individual Collections

Duluth has the same system as is followed in Sioux Falls. However, the population, 105,000, necessitates thirty-two individual collectors instead of sixteen. The director of public health, Lincoln A. Sukeforth, M. D., who supervises the collection, offers the statement that it is costing the residents of Duluth $375,000 annually for the collection of garbage, ashes, and rubbish. Disposal of garbage is made by incineration.

A system similar to that of Sioux City is followed in Winnipeg, Manitoba. All garbage, ashes, and rubbish are collected by the city, no direct charge being made to the individual householder. The av-

erage cost of collection of all material is $4.08 per ton, the city owning part of the equipment and hiring the remainder.

The information given previously has been secured through personal investigation, being taken from office files and actual observation acquired by direct association with the various collectors.

What deductions are we to draw from the facts and figures as submitted? I have cited the different methods of collection, municipal, private hauling, paid for directly, and contract-let by cities, as in Kansas City and Omaha. Personally, I favor municipal collection. This class of service was instituted in Sioux City in 1894. Our department operates economically and efficiently, the economy being due to the fact that the city has no money invested in equipment, which means no upkeep, depreciation, nor interest lost on money invested. The efficiency of the department is not only due to the method we have of doing our work, but also to the hearty cooperation of the employees in this department. Our men are all assigned to certain routes and they are taught that the cleanliness of their respective routes is observed more by the people who reside on them than by their supervisor. They are also taught that the better sanitary condition we have the lower our death rate will be, and Sioux City has one of the lowest death rates in the United States for any city of its size or larger.

Municipal rubbish collection assures a cleanliness that cannot be attained otherwise. As for the private contract system, paid for directly by the householders, it is entirely too expensive to be considered. The large contractor, having thousands of dollars invested, has his own interests at heart rather than that of the taxpayers and the result is costly, inefficient service. The contractor must also have his percentage for supervision and invariably, you will find this not less than four times as great as a municipality pays for the same service. In addition to this, the contractor must be supervised.

In Sioux City we feel that we can express ourselves on the contract system as it was tried here on two separate occasions during the past 32 years. As for a disposal plant, I have had no experience with incinerators or reduction plants, but I do know that hog feeding is the cheapest system if you want real economy.

PROGRAM OF A. A. E. FOR HIGHER COMPENSATION

(The following editorial from the March, 1927, number of the "Professional Engineer," official journal of the American Association of Engineers, presumably gives the program of the Association in its work for more adequate compensation for engineers.—Editor.)

Much has been written in this Journal during the past six months on adequate compensation for engineers. In the articles and editorials that have appeared it was shown that the engineer is the chief contributor to the wealth and comfort of modern civilization; that he is sadly underpaid; and that the profession by reason of its economic status is dangerously near the brink of unionism.

How is the engineer to get adequate compensation? He certainly is not going to get it by merely asking for it. He must work for it, not only individually but through cooperation with his fellow engineers.

It is common knowledge to the public that the average engineer of today is underpaid; in fact it is not uncommon to hear the public comment upon this predicament of the engineer. But the public is not going to fight the engineers' battles for them, they must do that for themselves.

The public always has been willing, and is willing today, to pay adequate compensation to engineers for services rendered to it, and if engineers will only get together and make a concerted nation-wide effort for adequate compensation, they will soon find public sympathy with them. However, it must be remembered that while the public will sustain cooperative effort to better the engineers' economic status, it will not sustain a dictatorship by either the employers of engineers or by the engineers.

Efforts for adequate compensation means more than the mere asking for it. It means organized and cooperative effort on the part of the entire profession; it means wholesome and enlightening publicity; it means standards that will proclaim to the public that the title "professional engineer" carries with it a certain standard of proficiency that the engineer has successfully passed or acquired; it means eliminating the exploitation of the profession by incompetent or so-called "pseudo" engineers; it means more active participation by engineers in community and civic affairs; it means

a broadening of the engineers' training in civics, economics and finance; and it means cooperation between the engineer and his employer.

Any program for adequate compensation of engineers must take in the entire gamut of professional welfare activity in order to be successful. Such a program must include the placing of proper registration laws for professional engineers on the statute books of every state; it must include curbing the activities of fake technical correspondence schools; it must include organizing the entire engineering profession into one national welfare association; it must include the adoption of standard minimum schedules of fees and salaries; it must include educating the politicians and public officials to the necessity of competent engineers in municipal employ; it must include a broader training of engineers in engineering schools and colleges; it must include a program of more active participation of engineering groups in civic and community affairs. It furthermore means the organization of local chapters of engineers in the larger communities through which the profession can make personal contact with employers of engineers for adjustment of inequitable salary schedules.

The annual turn over in engineering employment is today very high, in some cases as high as 75 per cent. This means that the employer is constantly training men at a loss of time and expense. Employers of engineers must be shown that by employing competent men at adequate salaries they will reduce their turn-over to the mutual benefit of both.

All of the foregoing the American Association of Engineers is fostering and supporting. The Association is fighting the engineers' battles for them. Ultimate success will be her reward, however, the greater the number of engineers that will enlist under her banner and actively support her program, the sooner a new day will dawn for the engineering profession. Let's all get in and boost A. A. E. by getting our engineering friends and acquaintances who are not already members to join and help put over this worthwhile program of A. A. E.

MUNICIPAL SANITATION IN VIRGINIA

By Richard Messer, Chief Engineer, Virginia State Board of Health.

(From the Virginia Municipal Review for February, 1927.)

Competition between the various cities and towns to secure new industries and more business, is growing keener each year. The municipality which fails to offer special inducements must expect new enterprises to locate at other places which present more attractive propositions in the matter of sites and satisfactory living conditions for the employees.

The era of the automobile and good roads has brought cities closer together. Whereas, formerly the majority of the people in a given place usually knew very little, and cared less, as to what was going on in the neighboring town with regard to public improvements, such as street paving and lighting systems; now there is an entirely changed point of view. "Our town is just as good and even a little better than any other of about the same size" seems to be the sentiment. Hence the voters are usually willing to go the limit in providing funds for such improvements which are necessary to make a town more attractive and more beautiful. The ultra-conservatives, those who think that the old ways and methods are good enough and that expensive municipal improvements should be postponed just as long as possible, are now found to be in the minority.

It is only natural that such improvements as paving, good sidewalks and brilliantly lighted streets appeal more to the average voter than the need of some of those other facilities which are not so striking or make so much show. Instances might be mentioned of many streets having been paved from curb to curb before sanitary sewer lines were put in. Later, when it was decided to build the sewerage system, the lines had to be located in the alleys so as to avoid tearing up the pavement. The same thing has happened with regard to paving streets in which water lines large enough to furnish adequate fire protection should have first been put in.

In Virginia epidemics of typhoid fever due to polluted water supplies are very rare. Within the past four years there have been only two small epidemics, and of these, one was at a lumber camp and the other in a town with a population of about 500. This is in contrast to the

many serious epidemics during the preceding dozen or fifteen years. The writer has personally investigated about forty such epidemics and in several of these the number of cases exceeded 100 with from seven to twelve deaths.

The officials of our municipalities and the citizens generally deserve a great deal of credit for the many improvements made in the various public water supplies. Whenever the State Board of Health has pointed out any defects which might result in the pollution of the drinking water, there has been very little hesitation in providing the necessary funds to remedy the conditions. A number of the cities have found it necessary to abandon the old sources of water and at great expense secure entirely new supplies. In this connection, it may be mentioned that since the year 1910 up to the present date, the number of people furnished with filtered water has increased from 180,000 to a total of about 700,000. The first chlorinating equipment in Virginia was installed in 1910. At the present time chlorinated water is furnished to over 900,000 people. This figure includes waters which are also filtered. In brief, it may be stated that all of the public supplies as delivered into the pipe mains, with a few exceptions, are reasonably safe, and most of them are also of good sanitary quality with reference to physical and chemical characteristics.

Under certain conditions it is possible for a water to become polluted after it enters the distribution system. Every now and then one reads in the technical journals of a typhoid epidemic in the country due to a cross connection between a polluted industrial water supply and a city distribution system. In order to save expense an industrial company may have a separate water supply for fire protection and also a connection with the city supply so that water will be available in case of failure of private system. In the past, several permits have been issued by the State Board of Health for such connections on condition that each such connection should have two check valves of approved design and two indicating post gate valves, so installed that all the valves can be effectively tested for tightness at regular intervals. However, experience has shown that with even these precautions, there can be no absolute assurance that under certain conditions polluted water may not gain access to the public supply. Consequently, several of the States have passed laws prohibiting cross connections of any kind and now require that industrial plants shall build elevated tanks and the system so arranged that any auxiliary water of the city supply shall be discharged into the tank above the high water level. In other words, any physical connection between industrial water supply of questionable sanitary quality and the public water works system is prohibited. Superintendents of water works should look into this matter without delay, keeping in mind that any cross connection, unless the industrial supply is pure, is a menace to the health of all the water consumers.

Extending the water distributing pipes so as to reach every home within the corporate limits has already been accomplished in a number of cities and towns. However, in the majority of places the percentage of families which depend on individual wells and springs ranges all the way from 5 per cent to 50 per cent. Such private water supplies are very likely to be of questionable quality as they usually are not far distant from a number of houses. Some of the families may have installed plumbing fixtures and provided cesspools for taking care of the sewage. In such cases the possibility of the serious pollution of underground waters is greatly increased. Often one of the principal reasons why pipe lines are not extended is due to the fact that property owners are satisfied with their individual supplies as they exist, not realizing the danger.

The extension of the sewerage system so as to serve all of the residences is usually slower than the extension of the water system. However, there are several cities in Virginia which are credited with having 100 per cent of all residences connected with the sewerage system. These are Covington, Lexington and Fredericksburg. The city of Harrisonburg is nearly 100 per cent, and there are a few other cities and towns with over 90 per cent sewer connections.

In order to find out in a general way the conditions existing in the smaller and medium sized municipalities with reference to sewerage facilities, and particularly to what extent surface closets are still being used, the State Board of Health has recently completed a survey of 88 such places. The results are summarized in the following table, which gives the number of places in which the percentage of homes connected with san-

itary sewers is as indicated in the first column.

Homes with Sewer Connections (Per Cent)	Smaller Places Population 450 to 1,000 (Number)	Medium-Sized Population 1,000 to 5,000 (Number)
Over 90 per cent	0	5
From 75 to 90 per cent	2	5
From 50 to 75 per cent	5	17
Less than 50 per cent	30	24
Total	37	51

In explanation it should be stated that the municipalities surveyed are not located in any one particular section of the State, but are fairly evenly distributed throughout the entire State. It is believed that a complete survey of all the smaller cities and towns would show about the same relative number of sewer connections as are indicated in the tabulation, namely, that three towns out of every four have less than 50 per cent sewer connections.

In the census for 1920 there is listed a total of sixty-four incorporated places in Virginia having a population of between 1,000 and 5,000. Of these 51 were included in the survey. Therefore the figures in the table represent fairly accurately the sewerage facilities in municipalities of this size.

Although there can be no question as to the advantage of sanitary sewers, nevertheless, a town may have no sewers at all and yet be rated by the State Board of Health as being 100 per cent sanitated, so far as the disposal of human wastes is concerned. Actually several of the smaller towns have been successful in securing such a rating by carrying out the provisions of the State Sanitary Law. In several other municipalities, partially sewered, the provisions of the law have been enforced in those sections in which there are surface closets and no sewers.

Under the provisions of the State Sanitary Law, as amended by an Act of 1926, it is unlawful for the owner of any house or other building which is used as a dwelling and is located within the corporate limits, to have a surface closet, unless such closet is maintained in a sanitary condition as described in the Act. The same law applies to areas for a distance of one-half mile beyond the corporate limits. Failure to comply is deemed a misdemeanor and upon conviction a person, firm or corporation shall be fined not less than five dollars nor more than twenty-five dollars. Each week's failure is deemed a separate offense.

For several years investigations have shown that more cases of typhoid fever and dysentery occur in smaller towns and cities in proportion to the population than in the rural districts or in the larger cities. To quote actual figures, there were in Virginia in the year 1925 only six deaths per 100,000 population in the group of cities having populations exceeding 25,000, as compared with the typhoid fever death rate of twenty-eight per 100,000 in the group of places with populations ranging between 500 and 1,000. The typhoid rate for the medium-sized places (1,000 to 5,000) was seventeen and the rural rate was fourteen deaths per 100,000.

The above statements should not be interpreted as implying that all cases of typhoid are due to lack of sewerage and the careless disposal of human wastes. There are a number of causes for typhoid fever, such as polluted drinking water, infected milk or food, and also cases caused by persons who are typhoid-carriers. However, the evidence does seem to indicate that much of the typhoid and dysentery is due to unsanitary surface closets, especially in the smaller towns in which there has been little effort to enforce the law referred to. This seems to be confirmed by the fact that these two diseases begin to appear at the beginning of the fly season, in April and May, and reach a peak in August or September, after which there is a gradual decline. Otherwise the cases would be more evenly distributed throughout the twelve months.

About one-third of the counties already have full-time health organizations. In some of these the health department includes a medical health officer, a sanitary inspector and nurses. Others have only the sanitary officer. In several instances, city and county authorities have entered into a co-operative arrangement for a joint health department. In all of these counties one of the most important features of the health program has been with regard to town and community sanitation.

More recently several inspectors have been detailed by the State Board of Health to assist municipal authorities in the enforcement of the Sanitary Law, particularly with regard to the type of surface closet which is best adapted to the unsewered districts according to the local conditions.

Sometimes the total expense of providing sanitary closets and maintaining such closets is nearly as much as would be the cost of laying a sanitary sewer. In one of the cities located in Eastern Virginia, a survey last year showed a total of about 250 closets, nearly all of which were in need of repair. Since then sewer lines have been extended so as to reach about 200 of the homes, and the owners of these have been notified to make connections.

In the average town the approximate cost of laying an 8-in. sewer line 400 ft. in length will vary from about $400.00 to $600.00. This includes one manhole, but does not include the house drains. The interest and sinking fund charges on this investment is about $50.00 per year. If there are five or six houses which can be served by such a sewer the annual cost per house will be about the same as for the cleaning of closets of the box and can type. If the conditions are suitable for sanitary pit closets, there would be no cost for cleaning.

Often the property owners oppose the extension of the sewer line because of the expense which will be incurred for the installation of house plumbing. plumbing fixtures inside the house are expensive, but there is no necessity of putting them in unless one prefers such fixtures for the added convenience. An outside flush closet of the anti-freezing type may be used. This meets all sanitary requirements and costs very little more than a properly built privy of the pit type.

Sometimes the citizens in an unsewered district are told that there is not sufficient grade for extending one of the city sewers, and that the expense of providing a separate outfall for a few houses would be too great. Under such conditions, the district, even if considerably lower than the main part of the city, may be taken care of by means of a sewage pumping station. Within the past few years pumps for handling raw sewage have been placed on the market and are in operation in a number of places. Within the last few months New Market has completed a system which includes three pumping stations. The new system at Warrenton has one. At Manassas a station has been in use for over ten years. In Norfolk and Portsmouth practically all of the sewage is pumped.

The cost of sewerage systems for towns of about equal size will vary according to the local conditions. When the topography necessitates laying sewers in deep trenches and when there is a considerable quantity of rock, the cost per mile of sewer may be excessive. Often an out-fall line of several miles in length may be required, or the sewage must be treated before being discharged into a river. The cost of these last two items may amount to 50 per cent of the total. Hence, any cost figures for one installation will not give indication as to the probable cost of a system for some other town. However, since the question of sewerage is one which is receiving more consideration each year in the smaller municipalities, the following figures, concerning four new systems, which were built during this past year, may be of interest:

Town	New Market	Wise	Warrenton	Woodstock
Population	600	840	1,600	1,800
Population per acre	5	6	7.3	8.2
Estimate number connections	150	150	350	361
Cost of outfall and disposal works	$ 4,800	$ 2,000	$29,860	$ 9,200
Per cent of total	19	9	39	23
Cost of collecting system	$21,100	$20,200	$46,290	$30,900
Per cent of total	81	91	61	77
Total cost complete	$25,900	$22,200	$76,150	$40,100

WATER PURIFICATION EXPERIENCES AT DETROIT, MICH.

By George H. Fenkell, General Manager, Department of Water Supply, Detroit, Mich.

(Paper read before Western Society of Engineers.)

During the past 30 years rapid and continued progress has been made in the design and operation of water filtration and purification plants. This has been due primarily to the great amount of painstaking research work that has been carried on in many places by engineers engaged in the design, construction and operation of water works plants, and to the prominence that has been given this work by the engineering faculties of the leading universities.

Water Department Public Service Utility

The citizens of large cities are demanding more and better service from public service corporations, which demand has been occasioned to a considerable extent by the great progress that has been made

in electrical engineering and the progressive policies that have been followed continuously and persistently by those great companies that are engaged in generating and distributing electric current. The public has become accustomed to receive better service from year to year from such companies as the Detroit Edison Company and the Commonwealth Edison Company, and it is taken for granted that the water works engineer can extend his plant and improve his service in a like manner.

The water department is considered more and more as a public service utility rather than as a branch of the city government that may be operated for better or for worse as the amount of funds available for the current year may make possible or expedient. This becomes apparent when one reviews the attitude that many state legislative bodies and public service commissions have taken when considering and passing on those matters that relate to water service and water rates. The importance of securing a pure water supply is becoming better recognized and appreciated even by those who lack an understanding of the fundamentals of water purification. The fact is demonstrated in the interest shown by the ever increasing number of people who visit purification plants and by the more practical expression of the public attitude through the support given to the advanced programs of construction.

Natural Changes and Development of Water Supply at Detroit

No city affords a more striking example of the natural changes and developments in water supply than Detroit. Since the city was founded the Detroit River has ever been the source of its water supply, and for more than a century it received but little contamination.

As is the case with all human progress and development, the gradual extension of Detroit's environs inevitably resulted in an increasing degree of contamination of its water which, if provision for purification had not been made, would eventually have become a menace to the health of the city. Perhaps this will be more readily appreciated when it is stated that the geographical situation is such that all flow of sewage is discharged into the Detroit River, which bounds the city on the southerly side.

Normal weather conditions prevailing, Detroit River water is not as impure bacteriologically and chemically as the sources of water supply upon which many other cities are dependent, but with the constantly increasing sources of contamination the water supply will unquestionably show a corresponding increase in contamination in the future which will demand the closest supervision of the water purification system.

Up to the year 1913 untreated Detroit River water was used for the city supply. During the years 1913-1915, inclusive, the only treatment necessary was sterilization by the use of calcium hypochlorite, which, when applied to the water in scheduled dosages, had the effect of rendering the water safe for domestic uses.

Chlorination Started

In 1915 a manually controlled chlorinator was installed and chlorine gas was resorted to as a medium of sterilization. The beneficial effects of the change in chemical control were almost immediately noted, and the use of chlorine gas as a sterilizing agent was continued for the succeeding eight years, during which time the type of chlorinator in use became obsolete and was replaced with three chlorinators of a more modern type. Following the first use of chlorine in 1913, each year found a marked seasonal increase in pathogenic organisms which demanded the use of increasing amounts of chlorine in control.

While it is an accepted fact that an unusual increase in the turbidity of a water will be accompanied by an increase in bacterial content, the only dependable indication of the degree of water contamination is the incubation of water samples at a temperature of 37°C, which can not be effected in less than 24 hours. Thus it will be readily understood that a decided increase in turbidity involved the application of chlorine in unusual quantities to insure the delivery of a safe water in times of probable excessive contamination. The results obtained were generally satisfactory from the point of sanitation, but the dissatisfaction caused by the odor and taste of chlorine in the water was a source of discomfort to those responsible for the delivery of a supply of palatable water.

The turbidity of the Detroit River water is normally low, rarely exceeding 50 p.p.m., excepting during periods of strong winds, heavy run-offs due to exceptional rainfalls and ice conditions which prevail during the early months of spring. The maximum recorded turbidity is 3,000 p.p.m.

Experimental Filter Plant Built

As a means of eliminating objectionable taste, odor and suspended matter from the water, in addition to reducing its bacterial content, various proposals were advanced and surveys accordingly made to determine the most efficient and economical method of treating Detroit's water supply. These matters engaged the earnest attention of the engineering staff of the department for over five years before a decision was made as to the method of water purification to be adopted. The most valuable information was obtained by the construction and operation of an experiment filter plant.

Careful consideration having been given to all proposals, it was eventually decided that only by the process of filtration could the city be assured of a permanent supply of pure water. The advantages of filtration were so evident that a program of construction was submitted and concurred in by the citizens. Actual construction of the filtration plant was commenced in 1920, and the plant was completed and placed in service in the month of December, 1923.

The benefits derived from the operation of the filtration plant are reflected in the character of the water now being furnished to the city. The reduction in the amount of chlorine is of prime importance, and frequent mention is made of the improvement in the quality of the water, which is interpreted as applying to the present day clarity of the water and the absence of chlorine taste and odor. The high percentage of bacterial reduction in the tap water is most satisfactory, and local and state health authorities accept the change in method of water purification as being responsible for a marked betterment in general health conditions.

Conditions at Detroit and Chicago

The problems that confront those that are charged with the construction, operation and the maintenance of a water system in Chicago are much the same as those that must be coped with by the same officials in Detroit. These relate not only to safeguarding the quality of supply, but also the many details of distribution and consumption.

The City of Chicago has an area of 204.94 square miles, while the area of Detroit is 139.04 square miles. The extreme length north and south and extreme width east and west of Chicago are 25.5 miles and 15 miles, respectively, while like dimensions in Detroit are 11 miles and 16 miles, respectively. The average elevation of the surface of the ground is 21.9 ft. in Chicago and about 45 ft. in Detroit. The elevation of the business section in Chicago is 14 ft., while in Detroit it is about 25 ft., and the highest ground elevation in Chicago is 93.5 ft. All elevations are referred to the surface of the water in Lake Michigan or the Detroit River as the case may be. There are about 3,275 miles of water mains and 376,000 service connections in Chicago, while in Detroit there are 2,147 miles of mains and 217,785 service connections. Chicago adds about 10,000 service connections yearly, while in Detroit its yearly increase amounts to about 19,000. The estimated population of Chicago in 1926 is 3,040,000, while the estimated population of Detroit for the same year is 1,345,443. The lake water front in Chicago is 22 miles in extent, while Detroit extends along the river a distance of 11 miles.

The Chicago water has a hardness of 131 p.p.m., while the Detroit water has a hardness of 96 p.p.m. Thus it is evident that while the Chicago water is somewhat harder it can not be considered as unreasonably hard when comparison is made with the supplies of many cities. The normal monthly temperatures of the air in Chicago for the months of January, February, July and August are 24°F., 26°F., 73°F., and 72°F., respectively, while temperatures at Detroit for corresponding months are 24°F., 25°F., 72°F. and 70°F. The mean annual temperature at Chicago is 49°F., while at Detroit it is 48.5°F.

As it is evident that the temperatures of the two cities do not vary greatly, the difficulties encountered with ice at the intakes, the depth that water pipes and service connections must be laid in order to prevent freezing, and the legitimate use of water during summer months for cooling and sprinkling and during winter months to prevent freezing of pipes should be very similar. The average annual precipitation is 32.96 in. at Chicago and 32.16 in. at Detroit, and as far as temperatures are concerned the peak load during the evenings of hot summer days due to sprinkling gardens and lawns will vary but little per capita. As housing and living conditions are about the same, the use of water for domestic purposes may be expected to follow quite similar lines. With air and water temperatures about the same, it

may be expected that there will be but little comparative difference between the quantities of water that will be used for cooling and condensing purposes during the summer months.

As viewed by the water engineer, there is one marked difference between the two cities, for the water in Lake Michigan has but little current, while the Detroit River in front of the City of Detroit flows with a very appreciable current. Because of the absence of current at Chicago and the diversion of the sewage from the lake, it has been possible to locate intakes at strategic points in front of the city, whereas at Detroit, which discharges its sewage into the river at many points along its water front, it has been necessary to obtain its water supply from a point well above the entrance of its pollution. This situation has had a marked effect on the development of the water system and most of the differences in design are attributable to it. As evidence of this effect, Chicago has established ten pumping stations, while the eleventh one will be placed in operation within a few months, but in Detroit there is at present but one intake which supplies one filtration plant, while the plans and specifications are only now being prepared for a second intake, filtration plant and pumping station, and it is expected that these will be in operation about 1930.

It is probable that the amount of contamination that must be combatted is somewhat greater in Chicago than in Detroit. The bacterial count of samples incubated at 37° and stated as the maximum, minimum and average for the year were in 1924 for Detroit, 30, 6 and 14, respectively, while at Chicago these were 210 at C. H. Harrison crib, 3 and 39, respectively; and during the calendar year 1925 these counts at Detroit were 41, 5 and 15, respectively, while in Chicago they were 2,100 at the Sixty-eighth Street crib, 6 and 104, respectively. The B. coli were 100 c.c. as determined in Detroit for 1925 and stated as maximum and average were 59.2, 2.8 and 24.1, while in Chicago the figures were 1011.0 at the Wilson Avenue crib, 0.1 and 38.4.

Chlorination at Detroit and Chicago

The maximum turbidity during 1924 at Detroit was 375 p.p.m. and 100 p.p.m. at Chicago, and in 1925 this was 350 p.p.m. at Detroit and 120 p.p.m. at Chicago. The average for the month in 1925 showing the least turbidity was the same for Detroit as for Chicago, namely, 1.0 p.p.m. The average turbidity for the year 1925 was 40 p.p.m. at Detroit and 8.6 at Chicago.

The last year that unfiltered water was used in Detroit was 1923 and the average use of chlorine during that year 2.18 lb. per million gallons, while for the same year Chicago used 2.37 lb. During 1925 Detroit used a maximum of 1.48 of chlorine, a minimum of .91 lb. and an average of 1.14 lb. per million gallons, while Chicago used a maximum of 4.12 lb., a minimum of 2.17 lb., and an average of 3.33 lb. per million gallons. Thus it appears that during 1925 Chicago used an average dose 2.92 times as great as that used in Detroit during the same period.

Results of Filtration

By filtration the water available at Detroit or Chicago can be made pure and wholesome at all times. While it would be possible to construct and operate a plant that would remove a large percentage of the bacteria of the raw water without the use of chlorine, the cost will not be justified. During 1925, analyses for B. coli with 10 c.c. samples indicated that the filtration plant caused a removal of 67.6 per cent; and through the use of such small amount of chlorine that there were no objectionable tastes or odor to be found in the water as delivered to the mains a total removal of 98.8 per cent was obtained.

While the turbidity of the raw water at Detroit sometimes reaches several hundred parts per million, the effluent remains nearly constant at 0.1 p.p.m. It can be understood how nearly complete is this removal when it is remembered that 2 p.p.m. can be detected in a drinking glass, 1 p.p.m. in a bath tub, and ½ p.p.m. in a glass swimming tank. As the removal of turbidity is practically complete, there will be no accumulation of mud in street mains. Such accumulations occasion frequent complaints, for whenever the flow is increased considerably these deposits are set free with sometimes serious results. Also, for the removal of mud from the mains it was formerly found necessary in Detroit to make frequent blow-offs at dead ends, and several men were employed continuously in this work. When raw water was delivered directly to the consumer, meters in the smallest sizes were frequently found to be clogged or stopped. To what extent this difficulty will be overcome through filtration can not yet be determined from Detroit experience,

but it is believed that it will be lessened considerably.

The most obvious advantages of water filtration, from the point of view of the average consumer, are improved appearance, that is, freedom from turbidity and suspended matter of all kinds, and freedom from pathogenic bacteria or the taste and odor of chlorine added to destroy them. Aside from these advantages, however, there are many other uses of water for which filtered water is much to be preferred, such as for domestic laundry work, for those purposes where it is necessary that the water be sterilized through the use of ultra-violet rays, and in ice plants, soft drink works and for many manufacturing processes.

All plankton and other larger plant and animal life are removed by filtration. This includes not only many microscopic forms of plant and vegetable life, but also moss and fish. Because of this there is an almost entire removal of fishy or other pronounced tastes and odors. When used in connection with filtration, the amount of chlorine needed to produce water that is satisfactory and safe is one-third or less that required when chlorination process is used without other treatment. This quantity is so small that its use is rarely objectionable.

General Method of Filtration

The general method by which filtration is accomplished is so well understood by engineers that but little need be given here by way of further explanation or description. Briefly, the plan may be divided into four parts, as follows: A low-lift pumping station which will raise the water to above the surface of the ground; a coagulation basin; a number of filter beds; and a clear water basin or reservoir. Between the low-lift pumping station and the coagulation basin some means must be found to introduce and mix the chemical that is used to produce the desired floc. A portion of this floc and of the suspended matter and bacteria in the water will settle out in the coagulation basin. The process of filtration is effected by passing the water through a bed of sand in the filtration plant, and the accumulation on the sand bed is removed at such frequent intervals as may be found necessary by washing processes with filter water. After filtration the water is chlorinated and a portion is stored in the clear water basin.

Through the accumulated experience obtained in the operation of the large number of filter plants that have already been constructed and the many experiments that have been made by engineers and others, it is now possible to build a plant that will prove economical and that may be depended upon to be reliable under all circumstances. There still remains much research work to be done, however, for in an examination of the details of design that have been used in the plants that have been more recently constructed differences will be found that can not be accounted for because of the variations in the quality of the water that must be treated. These are generally not serious, but the engineer will not be content to continue along without a decided effort being made to clear up some of the problems of hydraulics, sedimentation, chemistry and bacteriology that are not yet well understood.

Work at Detroit Test Plant

The experimental filtration plant was placed in operation in Detroit in September, 1917, to demonstrate that a filter plant designed in accordance with the usual practice could be operated readily under local conditions, to determine the maximum rate of filtration which could be used, the necessary amount of preliminary sedimentation that would be required, and the most suitable kind and amount of coagulant that should be used. It had a daily capacity of about 200,000 gal. and was under test from Oct. 1, 1917, to Sept. 30, 1918, and informally for several years following.

As early as 1923 it was understood from investigations made at that time that by 1930 the demand for water in Detroit would equal or exceed the capacity of the new filtration plant and pumping station. In 1925 the Division of Engineering was organized in the Department of Water Supply to design and construct an additional water supply system. The personnel of the new division was secured through the civil service examinations conducted by the Civil Service Commission of the city with the aid of the faculty of the Engineering Department of the University of Michigan. In January last a second experimental plant was placed in service with a capacity of 250,000 gal. per day. Through this it is hoped that some of the problems that affect the engineer engaged in the design of such structures may be solved or at least better understood than at present. The principal purpose of this experiment plant is to determine if possible the most effective means of coagulation.

Subjects on Which Varying Opinion Is Held

As a matter of interest to those engineers that are not engaged in filtration design and operation, a brief statement is included in which is listed a number of subjects on which there is no unanimity of opinion among engineers at present. Of course some of the variations in design must be attributed to local conditions, such as the size and topography of the site, the amount and quality of water that will be treated, and provisions that must be made for future extensions. Coagulating chemicals are added to the raw water both in the dry state and in solution. There are a number of mixing devices in use, such as stirring tanks, hydraulic jump, baffled channels, and through the use of centrifugal pumps located in the low-lift pumping station. As these devices vary, so is the time allowed for mixing the chemicals with the water. As evidenced by the design adopted, there is a considerable difference in time allowed for sedimentation of the coagulated water. There is probably no part of such a plant whose operation is less understood than that of the water as it flows through the coagulation basin. The methods to be employed at the inlet, at the outlet, through the use of baffles, or otherwise to secure and maintain a uniform distribution of velocities; provision for rapid and economical cleaning, and the determination of the most satisfactory area and depth as well as the required contents or capacity for any given case, are all subjects that must receive further attention. There also seems to be some difference of opinion as to the desirability of covering coagulation basins in northern latitude, but there is quite general agreement that the best possible methods must be employed to bring the water from the coagulation basins to the filters without breaking the floc.

In 1925 Dr. Ing. K. Imhoff, Essen, Germany, stated that: "Opinions on the design of settling basins for sewage treatment have often changed in the course of time, even today there is no general recognized rule." Perhaps it would not be wise, referring to the sedimentation of coagulated water, to make quite as strong a statement, but still it can not be said that the fundamental principles involved are well understood. Allen Hazen showed many years ago by mathematical analysis that the capacity of a basin for removing non-coagulating sediment is apparently independent of its depth and depends only on its area. The accuracy of this analysis does not appear to have been questioned, but many deep basins have been built in disregard of or opposition to Hazen's theory.

The size of the filter units varies greatly, each unit at Detroit has an area of 1,080 sq. ft., while Buffalo uses 1,400 sq. ft., Cleveland 1,454 sq. ft., and Buenos Aires uses 2,154 sq. ft. The present accepted rate of filtration is 125 m.gd. per acre, with an allowance for peak load. Operating conditions, however, in a city that can provide itself with a reservoir of ample capacity are quite different from those that obtain in Chicago or Detroit, where the output of the distributing pumping stations must meet the demand at all times unaided. It will thus be seen that a mere statement of capacity means little.

For some years the use of air in washing filters has been decreasing, but its use has not been entirely abandoned for the filters recently constructed in Denver make use of air for washing purposes. There is a considerable difference in the design of the underdrains, and while pipes with or without nozzles have been used quite generally, wood grating has been utilized in Baltimore, and cemented gravel at Toronto, Sacramento and elsewhere. Engineers agree that the filter sand should have a low uniformity coefficient, but the effective size of the sand in use varies from about 0.30 to 0.60 millimeters, or about 100 per cent. The supply of wash water is sometimes taken direct from the mains, and sometimes a special low-head pump is provided, discharging directly into the wash water pipe system. A storage tank for this supply is more frequently used, although there is a great variation in the capacity of these tanks.

The Matter of Storage

The design of the clear water basin frequently receives too little attention, for in a city served by direct pressure it becomes one of the vital parts of the system. In order that the filtration plant may operate at a uniform rate without following the minor fluctuations of the load, and that nevertheless the distribution pumping stations may follow the demand of the city, an amount of storage must be provided which depends upon the surplus available capacity in the filter plant. Thus with a filter capacity equal only to the average daily consumption for the year, would require in Detroit

the storage of water amounting to the average daily consumption of 12.8 days. By an increase in filter capacity of 10 per cent, this storage may be reduced to the equivalent of 3½ days' average demand. Likewise, with an increase in filter capacity of 20 per cent the storage must equal the demand for one day; with 30 per cent increase, the storage is reduced to 0.26 day; with an increase in capacity of 35 per cent, to 0.14 day's storage, and this it is believed is the most economical condition to use in Detroit. With an increase of filter capacity of 50 per cent, the storage is reduced to 0.05 day, and were the plant increased so as to provide from 80 per cent to 90 per cent excess capacity, the use of a clear water basin for equalizing purposes would be unnecessary. The capacity of the clear water basin should be sufficient to allow some supply in case of a shut down of the low-lift station or of the filters. It is desirable to operate the filters at as uniform a rate as possible, for better removal of bacteria and turbidity is obtained, the coagulant may be mixed with the raw water at a uniform rate, and uniform flow is obtained through the coagulation basins, with improvement in their efficiency. Uniform operation also allows more economical and efficient use of equipment.

Cost of Filtration

The cost of filtration varies with local conditions, size of plant, and the nature and extent of the foundation required. Exclusive of the cost of the site and the low-lift pumping station, it will vary from $12,500 to $25,000 per million gallons capacity for the maximum day. Operating costs including overhead and depreciation and including the low lift pumping station, will amount to from $6.50 to $13.00 per million gallons of water delivered to the mains.

An analysis of the yearly charges for filtration at Detroit shows that 42 per cent is chargeable to chemical treatment; 35 per cent to depreciation and 14 per cent to operation of the filtration plant. Of the yearly charges for the low lift pumping station, 72 per cent is for electric power, 14 per cent for operation and 11 per cent for depreciation.

Future Developments of Water Supply

It seems probable that there will be a continual demand for better water supply service. The electric companies may be depended upon to develop their services to the highest possible degree as the demand for better service continues, and the public will continue to expect a similar progressive spirit from other public utilities. It is fair to inquire how long this insistence for a higher quality and a better distribution of water may be expected to proceed. Of course this cannot be answered with any great precision, but it is interesting to speculate on what the coming years may bring forth, and it may not be unprofitable to give some thought to this subject now, although the changes may come but slowly.

With the installation of filtration plants treating the entire supply and the consequent removal of practically all turbidity and plankton life, this phase of the problem is practically solved. There has recently been some tightening of the requirements for the removal of bacteria, as evidenced by the bacteriological standards proposed by the U. S. Public Health Service in 1925, which limits the permissible density of the bacillus coli group, as follows:

Not more than 10 per cent of all the ten cubic centimeter standard portions examined shall show the presence of organisms of the bacillus coli group.

(a) When the number of standard samples collected is over twenty, not more than 5 per cent of all the samples shall show three or more positive tests out of the five 10-cc. portions comprised in any single sample.

(b) When the number of standard samples collected is less than twenty, not more than one sample shall show three or more positive tests out of the five 10-cc. portions.

This new standard is intended to replace a similar standard which has been in force since 1914. The new standard differs in detail in that it is more tolerant of occasional erratic results, but in general it is about twice as rigid as the old standard.

Supply of Softened Water

With the continued use of chlorine in connection with filtration, there is an almost entire removal of the various kinds of microscopic life. Water-borne diseases have nearly vanished. The hardness of the water, however, at Chicago and at Detroit is not as low as could well be desired. The hardness of water varies greatly, and this is, expressed in parts per million, for several cities as follows: Indianapolis 291, Columbus 210 to 109, Chicago 131, Cleveland 122, Buffalo 109, Detroit 96, New York 48, and Boston 10. No softening plants are in operation or in course of construction

for treating water from the Great Lakes for municipal purposes, and the reason that there is no active demand for this treatment is probably because other nearby waters are much harder. When these are made softer, and they eventually will be, there will probably be a more active demand that the Great Lakes cities adopt softening processes. At present a hardness of 100 p.p.m. is considered satisfactory in the Middle West. There is no doubt, however, that even this degree of hardness is an inconvenience and source of expense, and would cause serious protest if served to consumers who were accustomed to softer waters. The cost of softening water will be found to be considerable, for at Detroit to reduce the hardness from 96 to 30 p.p.m. the cost of lime alone under present conditions would be $4.20 per million gallons.

The treatment of water through the use of zeolite would be possible, but no estimate of cost nor in fact any evidence that this method of treatment has been considered for use in a large city has come to the writer's attention. The zeolite process is convenient for small installations and gives a perfectly soft water which is very satisfactory for use with soap, but for large municipal supplies it seems probable that the cost of the great quantities of salt required will prevent its adoption. The practice in Europe has been to avoid chlorination, and when used, to remove all traces of the treatment by dechlorination. This may be accomplished through the use of sulphur-dioxide gas, and it is quite possible that in the not far distant future the American public will insist upon this treatment.

Dual System of Mains Suggested

Finally, the possibility of installation of a dual system of water mains and supply must not be lost sight of, for, whereas this method of distributing water has heretofore been condemned because of the danger of use of water for human consumption from those mains which receive a supply from a contaminated source, it would now be possible through over-chlorination to safeguard such a supply perfectly. Among the advantages that may be named for the use of two water systems, one supplying the quantity needed for domestic consumption, and the other for many public, private manufacturing and commercial purposes where the quality of the water is of little moment, are those that are made possible because only a very small part of the total consumption will need further treatment than chlorination. Small pipes could be used for the domestic water supply and the treatment could be carried to much higher standards than with the present single water system. The zeolite process might be used, or by heating to moderate tempertures, the hardness might be reduced and the use of chlorine for this supply discarded. Ozone or ultra-violet ray sterilization, which are free from the taste and odor objections to chlorination, but which are more costly, could be economically used if only a small volume of water for domestic purposes required treatment. The addition of iodine, which has already been tried on a large scale, would be a matter of insignificant cost if only the domestic supply were treated. Even distilled water could be supplied were it found desirable, or a water with the most desirable mineral content could be produced. As the sizes of a large number of pipes in a city distribution water system are determined by fire department requirements, the present methods for computing the size of pipes in most cases would continue to be used to determine the capacity of the mains which would distribute the commercial supply.

Other Water Supply Improvements

The demand for filtration from the public comes from its insistence for better service. It does not distinguish between the different factors and elements that the engineer is inclined to view as presenting separate problems. Were a statement of this demand interpreted liberally it would indicate plainly that while our citizens have little time to make a scientific study of the water problem they are interested immensely in receiving at all times a constant supply of pure and wholesome water at adequate, uniform pressures. It should be noted that the cost to the individual consumer of a high grade water supply, especially under the favorable conditions that the lake cities enjoy, is so small that it will seldom act as a curb on the demand for any real improvement. Other civic improvements the citizen may want, but not be willing to pay for. A good water supply can be made self sustaining with a rate schedule which is not burdensome to consumers. Often an improvement, such as softening, can be made at moderate cost and will result in an actual net saving to many consumers. Under such conditions, if the consumers are convinced of

the value of any proposed improvement, they are not apt to refuse to approve it on account of the cost. To meet this demand for better service it becomes necessary to do more than to construct a filtration plant. The use of meters at once becomes a necessity in order that uniform pressures may be maintained, and while there may be little if any reduction in operation and maintenance costs through the use of meters, it has been found in Detroit that there has been a great saving in the cost of new works and improvements.

Elevated water tanks are just coming into use in the Detroit system, for it has been found that with elevated storage of 1.6 per cent of the average daily demand, and with proper control of the withdrawal of the water from tanks, the maximum demand on the distributing pumps is reduced about 10 per cent, and the frictional loss through mains during the time of maximum hourly consumption is reduced about 20 per cent. The cost of elevated storage is about $50,000 per million gallons exclusive of the cost of site and connections. The use of storage reservoirs is of course desirable, but it is needless to discuss this subject before the engineers of Chicago, for neither Chicago nor Detroit can furnish a site with a sufficient elevation.

It is possible to proceed in a number of ways, each of which will tend to improve the water supply. There are of course outlying districts where the system of pipes has only been partially completed that pressures may be expected to sag at times of high demand, but throughout the city generally the minimum allowable pressure should probably not be less than 50 lb. The most desirable minimum pressure for a given city is dependent upon a number of factors, such as the age, condition and thickness of the pipes, the age and nature of the plumbing fixtures in use and the topography of the city; but the department should be prepared to maintain this pressure throughout all seasons of the year excepting possibly during that period of maximum demand which, because of weather extremes, comes but once in a number of years.

The quality of the water should be safeguarded to some extent by the elimination of cross connections with impure supplies. The number of leaks in service connections can be reduced, and such leaks will be repaired more promptly when the pipes are laid only by the forces employed in the department of water supply. The personnel of the water department must be kept free from political or religious influence, and this can be accomplished through civil service regulations that are administered without political manipulation or interference. Leak surveys, hydrant surveys, the use of pressure gauges in selected locations which may very well be fire-engine houses, will enable the management to grasp the situation and make reasonable and economical plans for future extensions and improvements.

The Future

Much time has been spent by earnest workers in an endeavor to predict the growth of the Great Lakes cities for a period of from 30 to 100 years. There may be a disagreement in some of the details, but all of the investigators, and they include men engaged in finance and commerce, as well as engineers employed by the various municipalities, agree that a rapid and continued growth in population may be expected. To those who attempt to follow in one way or another the continuing demand that is being made upon public service corporations for better service, it must be evident that the public will insist that the discoveries and improvements that are made available through scientific research shall be utilized to produce better service or a reduction in charges.

The management of the municipal water department should of course do its part in bringing to the attention of others needed improvements and extensions. Engineers and others that are in a position through training or experience to judge truly of the importance of its statements, should be interested in and support any proper request for improved facilities, so that the non-technical public may have the benefit of the opinion of disinterested technical men on this necessarily technical subject.

THE MUNICIPAL WATER PLANT

By H. L. Brown, Superintendent of Water Works, Salina, Kas.

(From paper before annual meeting of Kansas Water Works Association.)

There is probably no question of greater importance, which faces a city, which receives its service from a privately owned public service corporation, than "Shall the city own and operate its own water works system?"

The officials of cities contemplating such a move, are confronted with a mass of statements and reports, both in favor of, and against such a move. There are a great number of cities which have made an outstanding success of municipal ownership, and there are numerous others, which have made a dismal failure. There are, of course, two sides to the question. The side of the public and the side of the public service corporation. They are wide apart for one principal reason, namely: ignorance. The education required to enlighten themselves is not difficult, indeed it is very simple, but the great trouble is that so many of those who need it most are not willing or are indifferent to such education.

A private water company in accepting a franchise or contract accepts with it the obligation to build, operate and maintain its water works system, in a state of efficiency that shall furnish a supply of water, adequate and of a quantity to the city and its inhabitants, for domestic sanitary and fire protection. The city granting such a franchise assumes the obligation to allow the water company to charge and collect rates for water and service furnished for private and public uses, that shall provide an income sufficient to yield a fair return on its investment. Such a return has been conceded by courts to be right and just.

Some of the Difficulties of Adjustment

Most of the difficulties arising between cities and privately owned water companies, have arisen over the determining of what is a fair value on its investment, and a fair return on that investment. Not only that, but the failure of the public to understand all of the elements of cost entering into the construction of the original plant, or the expense which must be incurred in operating the property and maintaining its integrity once the plant has been built, and established, are some of the things which cause trouble in adjustment.

The public in most instances is very unappreciative of the service rendered by a public service corporation, even if this service be of the best. On the other hand the corporation may have its own share of difficulties. Its officials are obliged to make the best of things, striving on the one hand to earn the dividends called for by the stockholders and on the other hand to maintain and operate the property so as to give satisfactory service to the public; without in any way excusing the corporation from its sins of the past or of the present, where they still exist. Today most public service corporations understand their own troubles, and I think just at present the fault lies more with the public than with the corporation.

Handicaps Under Which Private Companies Operate

In my opinion most privately owned public utilities are striving to give efficient and adequate service, under the existing conditions in the city in which they operate. However, there are certain items of expense which enter into the cost of service to the public, such as large sums paid executives in distant cities, the retaining of legal advice, large sums expended in legal battles with the city itself, expense of refinancing, bond discount, etc., cost of securing new franchises. All these items of expense enter into the rates paid by the consumers in that particular city and justly so. But couldn't the property be municipally owned and save those served at least part of this expense? Of course, there are instances where the service is inadequate, the plant not efficiently operated, the company, hampered by a short term franchise, is unable to secure finances for needed improvements or the local management not having proper cost records to enable him to operate efficiently, but such conditions only tend to antagonize the public against private ownership.

Why Municipal Plants Can Operate at Less Cost

Every city has the right to secure and furnish a supply of water to its inhabitants. And since water is such an universal necessity and the city so dependent upon it for its growth and development, there is every reason to believe that a municipally owned water works plant, if operated free from political influence, can furnish service to itself and public at a less cost than if privately owned.

Some of these reasons are: Most cities are able to finance themselves at less cost than a private corporation, their bonds going on the market at less discount and very little legal expense. They can so adjust their rate schedule to meet the needs of their particular city. For instance, a city which has a large industrial consumption can build up its rate structure giving this class of service its proper rates. This makes the rates more flexible than if controlled by a franchise, and at the same time saves city officials time and money worrying over long drawn-out franchise controversies.

Public Should Receive Benefit of Surplus

If there is a profit in the operation of a municipally owned water works plant, in excess of interest on bonds, operating expense, depreciation and a sum set aside for the retiring of bonds, if there be any, the consuming public should receive the benefits of such excess earnings, either in the form of betterments for the system or a reduction in rates. Great care should be taken to see that the rates are high enough to provide for all the above expenses and I believe it is just and proper that a rate be high enough to care for ordinary betterments. With the growth of the community it will be necessary to extend the facilities and the surplus should be used for this purpose and no other. In some cities where the municipal water department has laid up a surplus, attempts are made to divert the funds accumulated to other departments of the city. Of course, there is a possibility of an emergency arising which would make it necessary to use this surplus of the water department for other municipal purposes, but such funds should be returned as soon as the necessity for this action has passed.

Necessity for Up-to-Date Accounting System

There is probably nothing so essential to the efficient operation of either a municipal or private water department, than an up-to-date accounting system; a system which will give the superintendent or manager some reliable cost figures that he may be able to operate the plant intelligently and efficiently. Lack of this feature in operation is no doubt responsible for most of the failures in municipal operation. The time is not far off, in my estimation, when municipally owned water works plants will be required by State law to conform to some standard form of accounting. I understand the state of Pennsylvania now has in effect law of that nature. Privately owned corporations are not so negligent in this matter, because stockholders and directors usually demand such accounting. They at the same time must adhere to rules and regulations set forth by the respective public service commission of the different states.

There are few municipally owned water works systems which know their physical valuation. They set up nothing for depreciation and replacement. Why, if the consideration of such items are valuable to the privately owned plant, shouldn't they be of as equal value, or more so to the municipal plant? Every property owner is a stockholder in a municipally owned water works. The dividends he receives in the way of lower rates, service and betterments, depends largely upon the efficiency of operation. Get your municipally owned water works department on a business-like basis and the results will surprise you.

REASONS FOR DIFFERENCES IN BEHAVIOR OF IMHOFF TANKS

By Harrison P. Eddy, Consulting Engineer, Boston, Mass.

(Paper read at 1926 meeting of American Association for Advancement of Science, Philadelphia, Pa.)

The modern sewage disposal problem had its beginning about the middle of the past century, following the introduction of public water supplies. The early attempts to solve the problem were crude and empirical. Modern solutions, however, are based in large measure on scientific principles.

Fifty years ago the science of bacteriology was in its infancy. Its applicability to matters of stream pollution and sewage disposal had not then been grasped. It was not long, however, before it was shown that oxidation of the organic content of sewage was effected through the agency of living organisms. Particularly noteworthy are the researches of the Lawrence Experiment Station of the Massachusetts State Board of Health, begun in 1887 and still continuing. The studies made by investigators at this Experiment Station, and by others, established the basic principles underlying the oxidation processes of sewage treatment prior to the beginning of the present century.

The treatment of sewage in an effort to render it inoffensive was undertaken long before the principles involved were understood. Probably the earliest method was that of broad irrigation, or the application of the sewage to relatively level but practically unprepared areas of farm land, where it could be absorbed and purified by the soil. Later, when some of the fundamental factors became known, intermittent filtration was developed. In this method, which is a modification of broad irrigation, the crude or settled sewage is applied to the surface of carefully prepared areas of sand or other fine material. Another early method was clarification by means of chemicals. Later, filter beds of coarse

material were developed, with special devices for intermittent application of the sewage and with provision for ample aeration.

Experience soon showed that with practically all types of devices for oxidation of the organic impurities, preliminary removal of suspended solids by settling the sewage in tanks is desirable. Such tank treatment, however, produces a bulky, ill-smelling and objectionable residue or sludge. Study and research, in this country and abroad, demonstrated that such sludge, if allowed to remain in the tanks, undergoes bacterial decomposition or digestion which results in the liquefaction and gasification of a large proportion of the solids and the production of a residual sludge of relatively inoffensive characteristics.

The combination of the sedimentation of solids and their digestion has been utilized in the septic tank, the Travis tank and the Imhoff tank.

The septic tank is a sedimentation tank designed and operated so as to foster the decomposition of the settled solids in the absence of oxygen. It was originally believed that this process is capable of nearly complete conversion of the deposited solids with liquids and gases, experience, however, has shown that this view is not justified and that the proportion of solids thus converted is much less than at first thought. Furthermore, such tanks, unless covered frequently, give off offensive odors, produce black and foul effluents, and present numerous operating difficulties.

Because of these conditions the favor in which the septic tank was once held has turned largely to the two-story tank. The best type of two-story tank is that named after Dr. Karl Imhoff, who developed it for use in Germany in the Emscher District of which he is Chief Engineer. The Travis tank has never been adopted in the United States.

The Imhoff tank consists essentially of an upper compartment in which sedimentation of solids occurs and a lower chamber in which their digestion takes place. The two compartments are separated from each other by sloping partition walls on which the solids slide to a longitudinal opening or slot through which they pass into the lower compartment. The sloping partitions are arranged so as to trap the slot and prevent rising gases or solids from re-entering the sedimentation compartment. From the upper portion of the digestion compartment, gas vents or scum compartments extend to the top of the tank.

There are two primary functions of Imhoff tanks: one, the deposition, in the sedimentation compartment, of suspended solids contained in the sewage; the other, their conversion into inoffensive, relatively stable matter, in the digestion compartment.

The principal difficulties experienced in the operation of Imhoff tanks have been connected directly with the action going on in the digestion compartment. Solids that pass through the slots may be divided into two classes, namely, those of greater specific gravity than the sewage, which settle to the bottom, and those of less specific gravity, which float in the scum compartment. The proportion of solids of the latter class is small. Such solids comprise substances which have been entrained in the mass of heavier solids and thus are caused to settle in the sedimentation compartment.

The solids which are removed from the sewage by sedimentation, with the exception of sand and mineral detritus from storm water and certain industrial wastes, are essentially organic, although such organic matter contains mineral ingredients. These organic substances are in a state of decomposition owing to the action of bacteria and other living organisms, or their enzymes, present in the sewage and propagated in the digestion chamber of the tank.

The organisms decompose the organic matter into gases, soluble substances and insoluble material. Some kinds of organic matter are more easily and more quickly decomposed than others. Of the products of decomposition, the gases escape, by solution in the liquid, or by passage through the gas vents into the atmosphere. The soluble substances are dissolved in the liquid in the digestion compartment from which they escape, either by diffusion through the slots, or by withdrawal with the sludge. The relatively stable solids remain as sludge and scum until withdrawn. From 30 to 50 per cent of the weight of solids removed from the sewage escape in solution or as gas, leaving 70 to 50 per cent as solids in the sludge and scum.

The digestion of the organic matter results in the production of a practically inoffensive sludge, which is generally black, somewhat flocculent, and well filled with entrained gas as drawn from the tank. The digested sludge drains and dries readily when spread on porous

beds of sand or similar material. Digestion sufficient to produce these characteristics may be considered complete for practical purposes, although the residual sludge usually contains about 50 per cent of organic matter.

The complete conversion of the fresh sewage solids into well digested sludge requires time, the length of which is greatly influenced by temperature. At a temperature just above freezing, scarcely any digestion takes place, while at 70° Fahr., digestion proceeds rapidly.

In northern climates there is great variation from season to season in the temperature of air and sewage and, most important of all, of the solids and liquids in the digestion compartment. In summer, when the temperature in the sludge compartment may be from 65° to 70° Fahr., digestion is rapid, but in winter it is greatly retarded. The digestion process follows a seasonal cycle. In summer the sludge may be in excellent condition, deteriorating during the fall, becoming quite offensive in winter, and gradually improving in the spring. Obviously, therefore, the digestion compartment must be of sufficient size to accommodate the solids deposited in the late fall, winter and early spring, so that it will not be necessary to withdraw partly digestive and offensive sludge.

The solids as first deposited form a thin, voluminous sludge. As decomposition progresses, they are disintegrated and, being finer, tend to become compact. This tendency is aided by the weight of solids subsequently deposited. As a result of these conditions, the mass varies in consistency from a thin, watery material at the top to a comparatively thick sludge at the bottom.

Gases generated during the decomposition of the solids gradually increase in volume until they permeate and buoy up quantities of sludge which pass into the overlying liquid. If there is opportunity for the entrained gases to escape from the rising sludge the solids heavier than water will return to the sludge mass. In practice, however, the gases escape with some difficulty, and masses of sludge are carried into and remain in the scum compartments, thus forming a thick, bulky scum consisting of solids heavier than water as well as those which are of less specific gravity. If the sludge or the scum becomes extremely compact, the opportunity for the proper functioning of the organisms appears to be reduced and the digestion process is greatly retarded and may be quite incomplete.

At some plants, the gas rising in the vents has produced a light, voluminous foam, due to tenacious films enclosing the gas bubbles. At times this foam has accumulated in considerable masses, filling the gas vents, overflowing their walls, and spreading over walks and sedimentation compartments.

Excessive accumulation of scum in the gas vents, has been another serious obstacle to successful operation. In some plants the scum has risen above the tops of the gas vents and, in others, it has extended downward practically to the elevation of the slots. Under the latter condition, solids have been carried upward through the slots into the sedimentation compartment, from which they escaped with the settled sewage, greatly decreasing the efficiency of sedimentation.

Under some conditions scum formation is so great that the proportion of solids remaining in the bottom of the tank is so small that it is practically impossible to remove any solids in the form of sludge without first driving down the scum by breaking it with paddles, or streams of water, to liberate the gas. If scum is thus broken up and the solids are allowed to settle, they rise again in a comparatively short time, often within 24 hours.

In certain plants difficulty has been experienced in obtaining an inoffensive sludge that will dry rapidly on sludge-drying beds. Offensive odors have escaped from the Imhoff tanks at some plants, although generally speaking these tanks are practically free from odor.

While temperature has a most important influence upon the rate of biological action, there are a number of other conditions which affect the process favorably, or adversely, as the case may be.

Ample food supply and moisture are always present in the sludge compartment of an Imhoff tank. Although evidence is lacking, there is a possibility that different sewages produce sludges of such diverse composition that corresponding variations are produced in the predominant organisms, with resultant variation in the kind and intensity of biological action.

Light, oxygen, and inorganic poisons are of relatively small importance in the practical application of the process of digestion. The circulation of liquid between the digestion and the sedimenta-

tion chambers and the periodic withdrawal of sludge cause the more or less effective removal of products of decomposition. It is probable, therefore, that the "self-poisoning" of the essential organisms in the sludge is not an important factor.

The reaction of the sludge in the digestion chamber has a marked effect on the digestion process. In certain instances, notably at the Pennypack Creek plant at Philadelphia, Pa., the correction of acidity by the use of lime resulted in marked improvement in the behavior of Imhoff tanks. Valuable research has been and is being carried out in this connection at the New Jersey Agricultural Experiment Stations, at Harvard University and elsewhere. These researches have indicated the practicability of controlling the digestion process by the addition of lime, or calcium carbonate, to decomposing sludge. The addition of these substances makes it possible to produce (in the mass of sludge) the hydrogen-ion concentration most favorable for satisfactory digestion.

Another important factor is the retention at all times of ample quantities of well digested sludge in the digestion compartment. This requirement results from the necessity of providing material to "seed" freshly deposited solids with the proper kind of organisms.

The substitution of gas for water in the voids of scum may render it less easily broken down by organic activity than is the case with wet sludge. Furthermore, there is much less opportunity for washing out the final products of biological activity and correspondingly greater opportunity for self-poisoning of the organisms of decomposition. These conditions are particularly favored by allowing the scum to remain undisturbed for long periods.

In general, two kinds of decomposition develop: First, the production of carbon dioxide by the splitting of non-nitrogenous organic matters, or fermentation; and, second, the production of methane by the splitting of nitrogenous organic matters, or putrefaction. Both kinds of decomposition may be included in the digestion process.

The initial decomposition of solids in a digestion compartment, when first put into operation, results in the production of a large proportion of carbon dioxide, due to the fact that fermentation starts at a rapid rate. Under favorable conditions, however, the character of decomposition quickly changes and methane becomes the predominating gas produced, roughly 85% of the total volume. Hydrogen-ion control affords a means of hastening the second type of decomposition.

Aside from the purely biological and chemical factors, details of tank design are important. Among such details are length, depth and capacity of different compartments; area and arrangement of gas vents; and other significant features. Exact scientific data upon which to base design are as yet relatively meager. As experience and research adds to the store of knowledge, more and more intelligent designs can be developed, although the exercise of sound judgment will always be required.

Imhoff tanks must be carefully and intelligently operated in order that their functions may best be developed. Operators should keep adequate records and should make sufficient analytical determinations to guide them in the operation of the plants in their charge. Satisfactory results in the operation of Imhoff tanks are as dependent upon skilled operation as on good design.

From a study of the evidence afforded by certain installations of Imhoff tanks, conclusions may be drawn with respect to some of the important factors in their design and operation. It seems evident that mineral and heavy relatively stable organic matter, such as are present at times in sewage from combined sewerage systems, tend to prevent the formation of excessive scum and foam, whereas the coarse and uncomminuted solids from separate systems have the reverse effect. In the case of sewage from municipalities having very hard water supplies, the formation of insoluble soaps probably bring about a substantial increase in the colloidal solids of the sewage and favor the formation of foam and scum. It is quite clear that, due to variation in the quantity of suspended solids in different sewages, the design of the digestion compartment of an Imhoff tank should be based upon the quantity of solids to be deposited in it rather than on an arbitrary assumption of a definite number of cubic feet per capita.

All the evidence shows that temperature is a factor of fundamental importance in the digestion process and that the required capacity of digestion compartments is governed largely by the available temperature and by the duration of the periods of low temperature.

It is advantageous to draw sludge as early in the spring and as late in the fall as possible without removing offensive smelling sludge. It is also well to withdraw as much of the accumulated sludge as practicable, subject to the retention in the tank of sufficient volumes of favorably digesting sludge for "seeding" freshly deposited solids.

Preparatory treatment by fine screening appears to be beneficial, although not a necessity, because it affords a factor of safety due to the reduction of the quality of coarser materials which tend to form scum. The advisability of installing fine screens is largely a matter of relative costs.

In tank design and operation every effort should be made to secure uniform distribution of the deposited solids through the digestion compartment. Frequent reversals of flow is necessary for the successful operation of multiple compartment digestion chambers.

Deep tanks appear to have a decided advantage in preventing excessive scum formation and in producing a sludge of comparatively high density. Shallow tanks require substantially more digestion compartments capacity than do deep tanks for the same contribution of solids.

The evidence does not justify final conclusion regarding the comparative merits of small and large gas vents or the best arrangement for such vents.

Briefly stated, essentially unfavorable conditions are shallowness of tanks, inadequate digestion compartments, non-uniform distribution of sludge throughout digestion compartments, large number of digestion compartments, absence of heavy solids from street washings, relatively large proportions of insoluble soaps, low temperatures, and the establishment of unfavorable reaction in the sludge and scum.

Experience with the Imhoff tank, as well as with other developments of sewage disposal practice, illustrates the dependence of engineering upon science and research. In the absence of adequate scientific data, the early designs of Imhoff tanks were based upon more or less arbitrary assumptions. Experience has added much to knowledge of their behavior, but additional information is needed on both the biological and physical phases of the process of digestion. The sanitary engineer welcomes the assistance of the scientist whose research into fundamentals makes Nature the servant of man, not his master.

GRAVEL AS A ROAD SURFACING MATERIAL

By W. G. Parrett, Engineer, Vermillion County, Newport, Ind.

(Paper read at 1927 Purdue Road School.)

The three principal natural products used in the construction of our highways are Gravel, Stone and Sand. Almost every type of highway which has been devised may be made to utilize one or more of these materials for the greater portion of the pavement. However, the material must be brought to certain specific requirements for each of these various types of construction.

In many sections of the country, local gravel is the only available material for road building and perhaps no other material has so wide a range of uses in construction work.

Gravel may be defined as a mass of more or less rounded fragments of rock material which have been broken down, worn and shaped by the action of ice and water, collected and transported by the ice sheets and left in deposits known as glacial drifts.

The two great ice movements forming the gravel deposits in this state are known as the "Illinois Ice Sheet" and the "Wisconsin Ice Sheet", the former extending as far south as a line from Posey to Brown and from Brown to Clark Counties and the latter, to a line from Vigo to Franklin Counties. As the ice melted, rivers and streams were formed and have continued to transport the materials further on and deposit them in bars. These deposits are commonly known as River Gravel.

Gravel may be composed of almost any kind of rock material but the commonest pebbles are composed of quartz and the harder materials of fragmental rocks. When these rocks were broken down, their more readily attractable mineral ingredients were decomposed and having been subject to great wear by reason of their having been transported over great distances, that part which remains in our gravel deposits contains all the more staple minerals of rock formation.

Because of this wearing quality and because of the wide distribution of these deposits and the low cost of the material, it has become the most universally used ingredient in our different types of roadway construction and perhaps more

than any other material for the plain surfacing of the roads.

In the earlier day when roads were nothing but mere trails, gravel was occasionally used, by reason of its proximity, to make the worst places passable for what traffic came along and no attention was paid to the quality of the material or the method of placing it. In this way its value became recognized as a surfacing material and today, in this section of the country, no road is considered worth building unless it can, at least be surfaced with gravel.

In the lapse of time and the almost complete change in modes of travel, coupled with the intensive use of our more important highways, it became evident that the material in its natural state would not hold up, that a stronger binder was needed, hence the removal of the natural and the addition of an artificial binder, such as Portland Cement, Asphalts and Tars, and thus developed our higher type pavements.

Our highways of today should be divided into four classes, namely: Interstate or Federal highways, highways of importance to the state within itself, highways of importance to the counties within themselves and highways of importance to the smaller communities.

In the improvement of these highways, there should be some system or well developed program to follow whereby the proper type of road surface should be constructed to satisfy the traffic conditions of the territory which it is to serve.

There is no doubt but that we should construct the higher type pavement on the main highways such as the Federal, State and the more important highways of the County, leaving the less important county and the community roads to be surfaced with gravel, thus obtaining as widespread mileage of reasonable satisfactory roads as possible to construct and maintain within normal limits of finance and taxation.

The knowledge required for the proper design of a gravel surfaced road, where local materials are to be used, cannot be obtained altogether from books or papers on the subject, nor will any set of standard plans and specifications answer the purpose, as every road will present different problems in regard to the nature of the subsoil, drainage and the characteristics of the surfacing material. It is, nevertheless, necessary to keep in mind an "Ideal", or Set of Requirements that have been tried and found to be generally satisfactory.

One of the first things to be considered is the quality of the gravel in the locality; to determine whether it is, or can be made suitable for the purpose for which it is to serve. As the quality of the gravel generally varies in the different deposits in the locality and often in the same deposit, it is necessary that the person in charge of the selection, have a knowledge of the relation of the physical characteristics of the pebbles to the wearing qualities. Probably the best evidence is obtained by observation of the surface of a road on which the same material was used.

The Ideal gravel should consist largely of pebbles which are hard and tough and will offer great resistance to abrasion. They should be well graded from the coarse to fine particles in the proper proportion. There should be intermingled with the particles, some material which will bond them into a compact mass. A careful examination of the gravel, with regard to these characteristics, will give the desired information.

The Hardness and Durability of a gravel is determined by the mineral ingredients of the pebbles which constitute it. With a knowledge of these ingredients, the relative hardness can be and usually is determined by visual inspection. It can also be determined to a fair degree by sorting out the pebbles from representative samples and testing them with a hammer. By means of weighing, the relative proportion in which the more durable materials are present, can be determined. The durability or resistance to abrasion may also be determined by use of the Deval Machine. Pebbles of certain size are weighed, placed in the steel cylinder, set at an angle of thirty degrees, together with a number of steel spheres, and the cylinder given about ten thousand revolutions at the rate of thirty-three revolutions per minute. The sample is then removed and passed over a No. 16 sieve. The material passing through is weighed and the per cent of loss determined.

In considering the grading of the gravel, it should be kept in mind that all that makes a gravel road better than an earth road is the pebbles and that in order to produce a surface of maximum density, they should be well graded from

the coarse to the fine particles so that the minimum amount of binder, the weakest element, will be required. Natural deposits usually contain too large a percentage of the finer particles as well as particles of a larger size than desired. If the gravel in its natural state will make a surface that will support the traffic of the road under consideration, it is well and good, but if it will not, the excess material should be removed by screening leaving a gravel containing the proper proportions of the different sized particles.

Authorities differ as to the maximum allowable size of the pebbles, ranging from one to three inches in diameter, the smaller sizes having the preference. This is probably due to the demand for a smoother riding surface. For maintenance material, the larger size would be screened out for if left on the surface they will cause unequal wear and a rough surface. But in the construction of a new road, the maximum size allowable should depend largely on the grading of the pebbles and the thickness of the surfacing material to be placed on the road. The larger pebbles placed in the bottom of a heavy course will not damage but will be a benefit to the road.

To select a gravel that produces a hard, dense surface, the grading is just as important as that of aggregate for the higher types of roadway.

It is generally considered that no gravel is worth while for surfacing if it contains a larger proportion of particles passing a number eight screen than from thirty-five to forty per cent, and possibly that containing fifty per cent or more should not be called gravel.

No matter how durable the pebbles or how well graded, they cannot be successfully used for surfacing purposes unless they contain some substance which will bond them together so as to present a combined resistance to the disturbing action of traffic.

The principle cementing agent in most of our deposits is clay and this material generally occurs in excess of the required amount for binder. There seems to be the opinion among many that gravel which will pack in the shortest length of time, will make the best road. Gravel containing a clay binder will pack in less time but will give a poor wearing surface if the binder is present in excess of the required amount. When present in quantities of more than ten per cent the surface will become slick and even muddy in prolonged wet spells and also more susceptible to the action of frost in the spring of the year.

Other good binders, though not so widely distributed, are silica, Iron-oxide and calcium carbonate; of these, the latter, or a combination of calcium carbonate and iron where same can be found, makes the best natural binder.

The efficiency of the binder may be ascertained by observing the exposed bank of a gravel deposit. If the bank stands practically vertical and contains lumps composed of numerous pebbles cemented together, a good binder is sure to be present and the pebbles will cement in the roadway and produce a hard and compact surface. The bonding qualities of a gravel may also be obtained by the investigation of the surface of other roads on which the same gravel was used.

After the different gravels within reasonable distance of a proposed road have been examined, the screen test should be decided upon and incorporated in the specifications and the Contractors wishing to bid upon the work, advised of the source or sources of supply.

The design and construction of the roadbed, ditches and waterways should proceed in much the same manner for all types of roadway, although in comparison, those of the gravel roads have not received as great care and attention as on the higher type roads.

The matter of drainage, which receives little enough attention or consideration in the construction of our roadways of any type, is more important to the roadway having a gravel surface than those of the permanent type. Water is more damaging to the gravel surface than traffic. During wet spells the power of the binding material is weakened and the road ruts up and in the spring, if the surfacing is not heavy enough, breaks through under the action of frost. There is no reason to believe that the soil under the surface of the roadway contains less moisture than that of the adjacent fields and if it pays the farmer to drain the fields by the construction of drains every forty feet, why should it not pay the public to do likewise with their roads.

In the designing of a gravel surfaced road keep in mind the location or importance of the road as to the future

use as well as the present, that the work done will not be wasted should the road be rebuilt in the future. It is not always necessary to go to so much expense in obtaining just the proper alignment or easy grades, as the gravel road is not what is called a permanent type and small changes, both in grade and alignment, can be made at any time and at small expense. The shoulders should have just enough slope to drain the surface water and the subgrade be left flat or practically so.

Money is well spent in the rolling of the subgrade and on roads carrying considerable traffic and where the gravel is costly, in rolling the surface. Rolling brings out the weak spots and also prevents the gravel surface from being torn up by traffic until such time as it takes for the binder to function.

There are two methods of placing the gravel surfacing, the trench and the feather-edge method; the former is probably the better where the gravel is very expensive, the latter is the more commonly used and is better adapted for our methods of maintenance.

The width at which the surfacing should be placed, depends on the amount of traffic which the road will carry and the depth, ranging from five to twelve inches, should depend on the nature of the subgrade, the amount of traffic and the quality of the surfacing material.

Every precaution should be taken in the placing of the gravel so as to procure, when compacted, a smooth easy riding surface free from bumps and waves. Maintenance should commence at once and continue until this condition is satisfied. The better the condition and the smoother the surface, in which the road is maintained, the less will traffic affect it, the smaller will be the traction necessary to propel the vehicle and consequently the less wear of the surface.

As you have heard the subject of maintenance thoroughly treated in the last few days as well as Dust Preventatives and the application of oils and asphalts to enable the surface to carry increased traffic, it is needless to discuss these again. One subject upon which not a great deal was said is the cure for corrugations in the gravel surface.

Dr. Ladd of the Bureau of Public Roads has completed a report in which he determines the density of traffic at which the corrugations arise and a means of keeping them down. A Mr. W. H. Necker of Montreal, Quebec, also states that he has made a complete study and report which is filed with the Provincial Road Department and which can be procured by any interested party. His theory is based on the principle of resonance, with varying wave lengths according to the thickness of the metal and the quality and quantity of the material. He claims to have applied his deductions to the maintenance of sixty miles of gravel road and has been able to eliminate completely or rather to prevent the formation of such ripples.

However from some cause, probably lack of funds, none of these remedies have been universally adopted.

According to data compiled at the end of the year 1924, there were in the United States 467,905 miles of surfaced road, 52.2 per cent of which are surfaced with untreated gravel. In our own state at the end of the year 1925, there was a total of 73,112 miles of road, 44.2 per cent of which were gravel surfaced roads.

This enormous mileage of this type road and the enormous amount of public money invested in them show why so much time and study have been given to methods of maintenance. There has also been much study and research in regard to the conserving of what there is of value of these roads by surface-treating with oils and asphalts that will hold the gravel surface firmly in place under increased traffic. Also, in using the gravel surface as a base for a coating or carpet of various materials to act as a wearing surface.

It is evident that we cannot replace all these gravel roads or construct all the future roadways with permanent types of pavement and have the desired mileage, therefore we must salvage what there is of value in them and enable them to carry the increased traffic.

On many of our roads, gravel surfacing is giving satisfaction and as roads should not be built too far ahead of traffic requirements, the gravel surfaced road will be one of our principal types of roadway for years to come.

The gravel road built of local material is moderate in cost and is the type of road by which the greatest possible number of people may be benefited. It has become an absolute necessity to the rural communities in the expedition of

business, mail delivery, educational and social advantages and public health. When subject to the proper amount of traffic, and some are carrying three times that amount, it is comfortable to ride upon and easy of traction. It can be easily and quickly repaired with its own elements. It also makes the best of foundations upon which to construct the higher type pavements.

The enormous increase in traffic on our main highways has resulted in the intensive promotion and construction, during the last few years, of the higher type pavements. These types have presented many and varied problems. Is it not true that they have absorbed alike, the interest of the engineers, contractors, material men, publishers and the public, to such an extent that improvement in the design and construction of the gravel surfaced type of road has been almost forgotten.

On account of the economic importance of this type of roadway, should not the design and construction and the quality of the surfacing material receive more attention and study than it has in the past few years.

Many miles are yet to be constructed and much of the present mileage which was built without any regard to durability or suitability, will have to be reconstructed. Could we not, by no great increase in cost, so better construct this moderately priced road as to greatly increase its value as a road surface to the traveling public, thereby reducing the cost of maintenance and bringing the type to a closer approximation of the service rendered by the higher type and more costly pavements.

The old maxim that a structure is no more substantial than its foundation applies to roads as well as other structures so when the time comes that traffic requirements demand that we shall treat the surface or lay a carpet coat or even construct one of the permanent types of pavement, there will be a better base upon which to lay it and a saving in the cost of the new construction.

HIGHWAY MATERIALS CONTROL IN MICHIGAN

By Roger L. Morrison, Director Michigan State Highway Department Laboratory, Ann Arbor, Mich.

(Paper read at 1927 conference on Highway Engineering at University of Michigan.)

Materials control consists of the preparation of specifications under which the materials are to be furnished and the inspection of the materials to see that they comply with the specifications. Indirectly it also includes research work by means of which the specifications and inspection methods are improved.

Specifications

Generally speaking, specifications are based upon three things: first, actual experience with the use of given materials of varying properties; second, the results of special tests and experiments; and third, a combination of opinion and tradition. For example, the requirement that sand for concrete pavements shall contain at least seven per cent of particles passing the 50-mesh sieve is the result of construction experience which has shown that sands deficient in these sizes will make the proper finishing of the concrete difficult. The requirement that the sand shall not contain more than 65 per cent passing the 20-mesh sieve is based upon laboratory tests which show that coarse sands produce stronger mortar than fine sand. The requirement that coarse aggregates for concrete work shall be practically free from thin or elongated pieces seems to be based primarily upon opinion and tradition.

As our knowledge is increased through experience and research the specifications become less a matter of tradition and more a matter of demonstrated facts. It is rather surprising that in spite of the vast amount of research which has been carried on for many years there are still many specification provisions the value of which has never been determined with any exactness, even though their enforcement costs thousands of dollars. Investigations may show that some of these provisions are entirely sound, that others can be considerably modified without detriment to the work, and that still others are worthless, if not actually harmful. In any case it can be easily demonstrated that the expenditure of large sums for research along these lines is an excellent investment.

Of course specifications are always governed by the limitations of production methods, and it is folly to make the standards so high that the increased cost of production is greater than the resulting benefits. Fortunately production methods are being constantly improved so that requirements can be correspondingly raised without unduly increasing the costs.

Many who are concerned with highway work have a very hazy idea as to the manner in which specifications are formed and even some engineering graduates with a few years' experience seem to think that they are the product of some supernatural inspiration or infallible wisdom. Therefore it may not be improper to describe briefly a process which is entirely familiar to many of those present.

The principal source of specifications for all engineering materials is the American Society for Testing Materials, an organization of about 4,000 engineers, chemists and others who are engaged in the manufacture or use of such products. In this organization there are a number of committees, as Committee D-4 on road and paving materials, Committee C-1 on cement, etc. Taking Committee D-4 as an example, it is composed of about 70 members and is divided into two sub-committees, one on bituminous materials, and the other on non-bituminous materials. These sub-committees are further divided into sectional committees of four or five members, each section being concerned with a single material only. The committee members are rather carefully chosen with regard to their knowledge, experience and opportunities for investigation along special lines.

A detailed discussion of the exact procedure in framing or revising specifications is hardly necessary but it may be said that they are carefully considered first by the sectional committees, then by the sub-committees, then by the whole committees, and finally by the entire society. Usually a specification is first published as "tentative" for a year or so, and then, if it proves satisfactory, is advanced to "standard."

Another organization which has a large influence upon specifications for highway materials is the Committee on Tests and Investigations of the American Association of State Highway Officials. Membership on this committee is confined to testing engineers of state highway departments and representatives of the U. S. Bureau of Public Roads. The specifications of this committee are usually based upon those of the American Society for Testing Materials, and the modifications of the latter are often very slight. Some materials and testing methods are specified by this committee which are not covered by the A. S. T. M. The members of the committee also engage in a large amount of co-operative research work, certain investigations being conducted simultaneously in several laboratories as a matter of checking.

Several other national organizations are engaged in the framing of specifications for various materials so that the individual engineer usually needs only to refer to a standard specification or modify it to suit his particular conditions, except in the case of certain materials which have never been fully covered by standard specifications.

Detailed Specification Provisions and Tests

Cement. The Michigan State Highway Department uses more than a million barrels of cement each year, and it is very important that it shall be of good quality. It must not "set up" before it can be properly placed and finished but it should become hard within a few hours thereafter. It should not contain free lime which will cause excessive changes in volume upon hydration, and it should be ground to the proper fineness, as cement which is retained upon a 200-mesh sieve has very little strength. These properties are determined by the so-called 24-hour tests of setting time, soundness and fineness. As is well known, the tensile strength in a 1:3 mortar is determined at 7 and 28 days.

It is true that cement is frequently tested during the process of manufacture but there are many things which can go wrong in spite of careful control. Flooding of quarries, sudden changes in chemical composition of the raw materials as received at the mill, variations in the proportions of limestone and clay, insufficient grinding of the raw materials, improper burning of the clinker due to overcrowding the kilns, or other reasons, the addition of too much or too little gypsum, insufficient grinding of the clinker, and dampness getting to the finished product, are all possible sources of trouble. Inferiority of the cement due to any of these causes can usually be detected by the physical tests, but occasionally chemical tests are needed.

Aggregate. The specifying and inspection of aggregates were covered in detail in a paper presented before the Conference last year, so that it seems unnecessary to include these materials in the present discussion.

Water. Specifications usually state that water to be used in mixing con-

crete shall be practically free from acids, alkalis, oil and vegetable matter. The total solids are determined in the laboratory but the most important test is that for mortar strength in comparison with water which is known to be satisfactory.

Reinforcing Steel. The reinforcing bars should be strong enough to take the stresses for which they are designed and should be soft enough so that they can be bent into the required shapes with no danger of cracking. These properties are tested by pulling the bars apart and bending them around pins.

Pipe and Tile. Clay or concrete culvert pipe, sewer pipe and drain tile must be sufficiently strong so that they will not be crushed by the loads which will come upon them and they must not absorb too much water. They must also conform to certain measurements so that they will fit together properly. In the case of concrete pipe the details of manufacture are specified because many manufacturers look to the specifications as a guide in producing pipe of the required quality.

Other Materials: There are, of course, many other highway materials which are covered by specifications, but to list them all would take entirely too long. Each material is considered from the standpoint of the function which it has to perform in use. The properties which make it most efficient in service are determined as nearly as possible and covered in the specifications, together with the tests which most accurately measure those properties.

Inspection Methods

Inspection may be performed at the producing plant, in the laboratory, on the job, or at any two, or all three, of these places depending upon the nature of the material and the circumstances surrounding its production and use.

Plant Inspection. When materials have to be rejected, the smallest loss occurs if they can be rejected at the plant before shipment. In order to have efficient plant inspection there must be a large enough output to keep an inspector busy and the materials must be of such a nature that complete inspection at the plant is possible. Cement, reinforcing steel, pipe, and bituminous materials can be completely inspected (except for damage in transit) before shipment, but the output is seldom sufficient in the case of cement and bituminous materials. The next best thing is to take samples at the plant and test them in the central laboratory. The difficulties due to small volume can often be overcome in the case of steel by employing commercial laboratories which have a large number of clients. Aggregates can be inspected at the plants but it is doubtful if producing and inspection methods can ever be made so exact that plant inspection of aggregates can be made final in all cases.

During the past season the Michigan State Highway Laboratory had its own full time inspectors stationed at one cement mill, one pipe plant, and approximately 20 aggregate plants. Inspection was also handled from time to time by laboratory employees at one other cement mill, and at five other pipe and tile plants, while plant inspection of various kinds, mostly in other states, was handled by three other state highway laboratories and two commercial laboratories under the supervision of the Michigan Laboratory.

Job Sampling and Inspection

Efficient materials control involves a certain amount of job inspection regardless of previous plant or laboratory testing, and it should be noted that the specifications cover the materials at the time they are placed in the work. Every possible effort is made to keep inferior materials from reaching the job, but plant inspection or sampling, and laboratory approval of samples, do not give the contractor permission to use any inferior materials which may have "gotten by" the previous inspections. Some of the inspection methods which should be used on the job will be discussed briefly.

Cement. Except for rare cases of misunderstandings, all cement shipments are sampled, and in some cases, subjected to 24-hour tests, before shipment. Usually the project engineer will have a 24-hour report before the car arrives, but it should be inspected to see that both doors are sealed with laboratory seals, and that there has been no damage in transit. If it is necessary, for any reason, to send in a check sample, some cement should be taken from one sack out of every 40 sacks and these small samples should be combined to make up the laboratory sample. Stored cement should be held for the 7-day test results.

Aggregates. If aggregates are obviously below specification requirements they should be rejected on the job even if the cars bear inspectors' cards, but samples should be taken and sent to the laboratory for retest and record. Ques-

tionable aggregates should be sampled and held for laboratory reports. The sampling should be done very carefully so that the sample will be truly representative of the shipment, a number of small samples from different parts of the car or stock pile being combined.

Reinforcing Steel. Ordinarily there is little to do in the way of job inspection of reinforcing bars except as provided in the general specifications. If it is necessary to send samples to the laboratory two 24-inch samples of each size should be sent, one for the tensile test and the other for the cold bend test.

Pipe and Tile. Before pipe or tile is accepted upon the basis of samples submitted to the laboratory it should be given a visual inspection and any defective pieces should be culled out.

Bituminous Materials. Job inspection of bituminous materials ordinarily consists merely of sending check samples to the laboratory, as the original samples are taken by employees of the producer. Care should be taken to see that these check samples represent the material as a whole, and not just the top layer. The sample containers should be tight and free from oil or other materials which might affect the quality of the sample.

General. Sampling of materials in the field should not be done by an untrained laborer or a contractor's employee. It sometimes happens that when the Laboratory recommends rejection a reply is received stating that the sample was taken by an inexperienced man and that a new sample will be submitted. This, of course, means unnecessary expense and delay.

Inspection Difficulties

One of the greatest difficulties in handling the inspection of materials for the State is the failure of contractors to give project numbers when ordering the materials. This is especially true in the case of reinforcing steel, aggregates, pipe, and bituminous materials. For example, a steel company in Illinois or Ohio will get an order for bars to be shipped to the Doe Construction Company at Peewee Siding, Michigan, and the order may or may not include the statement that it is for State highway work. If this information is not given then the bars are shipped without inspection and it is necessary to have samples sent in from the job. If it is known that the work is a state project, it has been customary for the steel company to notify the commercial laboratory so that the bars have been inspected and reported to us. The next step has been a guessing contest in the Laboratory office as to the location of Peewee Siding. There is no way to tell whether it is in Monroe County, Gogebic County, or some county in between, and therefore there is no way to tell what engineer should get the reports.

The same thing happens in the case of aggregates, except that it may be more confusing if a contractor has a State job and a county or city job under construction at the same time and with the same shipping point. The situation may be further complicated by a statement upon the order that the aggregates are to pass State specifications, although they may not be intended for State work.

Clay pipe is often ordered through local dealers who instruct the producer to ship the pipe to Richard Roe at a certain point. It may be that Roe is a foreman for the Doe Construction Company, and there is no possible way for the producer to know even that the pipe is for State work, when the project number is not given.

The identification upon a plant sample of bituminous material may say that the car is shipped to a certain county road commission. If no job sample is sent in, with further information, we naturally assume that the material is for county work, but when the county is billed for the testing the Accounting Department at Lansing may be advised that the material was for State Trunk Line Maintenance. Even where that much information is given in the first place, there is often much trouble involved in getting the maintenance section numbers.

The Laboratory wishes to co-operate in every reasonable way with engineers, contractors and producers and in return there is no one thing which would be more appreciated by the Laboratory than the assistance of all concerned in seeing that project numbers are given whenever materials are ordered.

HIGHWAY TRANSPORTATION IN DETROIT REGION

By Leroy C. Smith, Engineer-Manager, Board of Wayne County Road Commissioners, Detroit, Mich.

(Address delivered at Michigan Engineering Conference, Detroit, Feb. 4, 1927.)

Twenty years ago no traffic problem existed; any more than a traffic problem

now exists in the air. Streets were paved primarily for the purpose of improving the abutting property, doing away with dust nuisance and to improve sanitation. Roads were built to bring the products of the farms to the nearest railroad station. Today the expansion in street and road development is brought about largely by traffic congestion and the need of connecting the great centers of population with new arteries of travel.

The motor vehicle has led the way. Increase in registration has been the barometer for highway appropriations. This fact is true throughout the country but in no territory has the use of motors been so universal as in the Detroit area. Wayne County's registration in 1926 exceeded the registration in thirty-two states of the Union. Notwithstanding the great increase of population the motor vehicle has forged ahead. The ratio of population to motor vehicle registration has advanced from one car to twenty persons in 1916 to one car to three and one-half persons in 1926.

Western Avenue out of Chicago is a heavy traffic lane. The Boston Post Road attracts travel with its miles of thirty-six foot pavement, but at least three thoroughfares in the Detroit area exceed the traffic shown on these most important highways of the country. Fort Street at the River Rouge bridge had on July 5th, 33,537 vehicles of which 4,440 were foreign cars, 800 were busses, 750 were trucks, 11 were street cars, and only 32 were horse-drawn vehicles. Woodward Avenue, a 200-foot superhighway in Oakland County at Detroit city limits, recorded 38,852 vehicles, of which it is interesting to note that only 15 were horse-drawn. This was only a 14-hour count. Sixteen thousand eight hundred and twenty-two vehicles passed a given point on Gratiot Avenue at the Seven Mile Road on a 14-hour count.

You gentlemen, therefore, are visiting a city whose motor vehicle traffic leads the nation. This is logical because here is the center of the motor industry and probably here greater thought and endeavor has been given to serve the motor vehicle with the necessary tracks to run upon.

For 20 years Wayne County has been endeavoring to keep abreast of the traffic tide. They have attained some measure of success but based upon the per cent of increase in registration of motor vehicles per year she has fallen behind in increasing the square yardage of pavement, which is the track to be utilized by this form of transportation.

Those of you who wish to study traffic problems, the expansion of a highway system, right-of-way problems, grade separations, and other accessories of the modern highway, can well afford to give this territory your attention. A city increasing in population and territory by leaps and bounds and a motor vehicle registration increasing at a greater pace, makes some of the most optimistic predictions as to highway requirements soon become the present day necessities.

The Board of Wayne County Road Commissioners, in 1906, launched a highway improvement program with an initial appropriation of $85,000. This was divided, as has been the custom in most communities starting road improvement work into a number of short stretches of road. The desire in that day was to get out of the mud. In an ambition for mileage better judgment as to width was sacrificed and several improvements were made with a paving width of 12 and 14 feet. Today, 20 years later, appropriations for highway improvement by Wayne County exceed five millions of dollars per year, and the writer believes that the necessity for present day expansion is as great as ever before.

Twenty years ago a county road improvement consisted of some drainage and grading and the application of a road metal—probably stone or gravel. Today the improvement of a highway includes a wide grade, a wider right-of-way, a pavement 40 feet or more in width; it includes the construction of necessary bridges over streams; grade separations with main-line railroads; direction signs, safety signs and lights; comfort stations for the convenience of the traveling public; beautification of the roadside, sodding, planting of young trees and preservation of existing trees. All these things are necessary and must be provided for, just the same as stations, yards, and terminals have been provided for railroads. A highway system which does not provide safety and convenience is lacking.

Since the inauguration of a road-building program in Wayne County, six million square yards of concrete pavement have been laid, 55 modern bridges and 22 grade separations have been constructed, 25,000 trees have been planted and 10 public comfort stations have been built.

So much for the past.

As the physical improvements in the great network of highways in this district have improved, it became apparent to the builders that additional space for right-of-way should be provided for future expansion. If immediate action were not taken towards the acquiring of future widths, the very cost of the projects would defeat them.

In co-operation with the Detroit Rapid Transit Commission, the counties of Macomb, Oakland and Wayne launched a plan for the acquiring of future thoroughfare rights-of-way, which in the years to come will do more towards the solution of congestion than any other single act approved by the governing bodies of the counties concerned. This plan has been called the Master Plan, a very appropriate name.

It is briefly described by laying the territory out with a gridiron of superhighways 204 feet wide every three miles north and south, east and west, making every section line road 120 feet wide and every quarter line road 86 feet wide. These great highways cover the entire territory within the twenty-mile circle of Detroit. They approach the city and enter it to approximately the six-mile circle. It is unfortunate that the plan could not have been launched years ago and the public had the benefit of 204 and 120-ft. highways on the main thoroughfares of Detroit right down to the city hall.

This was not unthought of by men who planned Detroit, for in 1806 the Governor and Judges plan called for many 200-ft. highways and 120-ft. streets. Washington Boulevard, Cadillac Square and Jefferson Avenue East are the remaining remnants of such a plan. Had that plan not been encroached upon by less far-seeing successors our traffic problems would be lessened to a great degree.

Many of our far-seeing business men still believe that the solution of the down-town traffic problem should come through the opening up of great thoroughfares 200 or more feet in width. This would provide a means of individual transportation which could only be equaled by subway or elevated trains.

Let us return to the wide thoroughfares in the suburban region.

The launching and the approval of the Master Plan immediately brings desirable results. A policy has been adopted by the Road Commissions of the three counties named of making no road improvement except that the right-of-way shall conform to this general plan and that the funds for that right-of-way must be provided for in connection with financing the road. Again, the Master Plan has been placed upon record with the Register of Deeds and Platting Boards of the counties concerned, thereby making it necessary that when land is subdivided, right-of-way in accordance with the Master Plan shall be dedicated to the public. This provision alone is saving millions for the taxpayers of this territory in future road and street widenings.

The question is often raised, especially by those unfamiliar with Detroit territory, as to the necessity or advisability of a highway 204 feet in width.

Who can say that Washington Boulevard is too wide or that its width is a detriment to property facing thereon? Its very width has made abutting property valuable. The great thoroughfare, —Woodward Avenue, is 200 ft. wide. With its two pavements 45 ft. in width, ample space between the curb and buildings for utilities and central strip which may be utilized for parkway, rapid transit or whatever may be developed for the good of the community is provided for all time to come.

The Master Plan changes the Detroit area from a spoke-of-the-wheel city layout to the gridiron system. This makes possible and encourages the building of new centers. The intersection of two superhighways leads to a business development. If the Master Plan does nothing more than to spread the population over larger areas it will have been worth its cost.

To make effective and uniform the principles outlined by the Master Plan, Oakland, Macomb and Wayne Counties are bonded together through what is known as the Superhighway Commission. This Commission consists of the Boards of Road Commissioners of the three counties and the State Highway Commissioner.

Their function is to acquire right-of-way only. Funds may be raised to the extent of one-half mill tax upon the assessed valuation. Laws are available whereby the benefit of wide highways may be assessed upon the property.

Much has been said about co-ordinating the efforts of the various governmental agencies of cities, villages and counties towards a common end. I know

of no combination of commissions or boards which have accomplished so much without the expenditure of money as has been brought about through an agreement on the Master Plan by the officials of Detroit, Wayne County, Oakland County and Macomb County.

Through the co-operation of the State Highway Department the greatest superhighway development has been made on Woodward Avenue. The next big project is the great east and west thoroughfare, the county line between Oakland, Macomb and Wayne counties—the Eight Mile Road. This is to be accomplished through the operation of the Assessment District Act, commonly known as the Covert Act.

The improvement of a superhighway right-of-way must be determined by the needs of the territory traversed at the time each step in the improvement is taken. Several different examples of treatment exist in the Detroit Metropolitan Area.

Much of the 204-ft. right-of-way on Southfield Avenue has been dedicated, although at the moment the traffic is being well taken care of (except on Sundays and holidays) by a single 20-ft. strip of concrete centrally located. There are no interurban tracks on Southfield.

How and when the superhighways are to be developed is not nearly as important as is the early acquisition of the right-of-way itself. It is important that the land necessary be acquired now, before improvement in the shape of expensive buildings makes acquisition expensive or impossible.

Work has already been started on Fort Street Superhighway. This passes through the City of Lincoln Park and on the city line of Wyandotte, connecting up all the down-river cities, and with the approval of Detroit's common council the 204-foot width will be carried within the City of Detroit as far as the River Rouge-Fort Street bridge. This bids fair to be Wayne County's greatest highway.

Mack Avenue, from Cadieux Road northeasterly, will be carried out through Wayne and Macomb counties, over thirty miles, passing around the bottle-neck in Mount Clemens and connecting at New Baltimore with state trunk line No. 27, thereby relieving Gratiot Avenue congestion.

The Northwestern Highway, a radial road bisecting the territory between Grand River and Woodward Avenues, is already launched as a right-of-way project between Oakland and Wayne counties. It pierces the city limits of Detroit three miles, thereby connecting up many important north and south and east and west thoroughfares.

Proper planning now, and the agreement of the three counties upon a program of development for years ahead, in accord with the future growth of Detroit and her neighboring cities and territory, does not at this time cost an excessive amount but in the future may well save tens of millions of dollars.

RESOLUTIONS ON ENGINEERING EDUCATION

The following set of resolutions submitted by its Committee on Engineering Education, through its chairman, Dr. J. A. L. Waddell, has been endorsed by the Board of Directors of the American Association of Engineers:

1. All really efficient technical instructors should have their present salaries materially increased; but the inefficient ones should be ruthlessly dropped, because the injurious effects they produce upon the characters of their pupils more than effect the value of their teaching.

2. No one should be allowed to teach engineering students, even in the most subordinate capacity, until after he has had at least three years of practice in field or office—preferably in both.

3. Inbreeding in faculties is bad policy, tending to get the curriculum into ruts and preventing its development. By bringing into the institution graduates of ability from other technical schools, new ideas will be suggested and adopted, and progress will thus result.

No man who is mentally or physically unfit to assimilate a rigid course of instruction should be permitted to undertake the study of engineering; because, not only does he waste his own time by so doing, but also he acts as a drag to hold back the brighter students. There should be evolved for and utilized by every school of engineering an effective method of selection of candidates that will rigorously exclude all incompetents.

5. Too early specializing in any engineering course is to be deplored. If there must be a division in teaching the various lines of engineering it should

not take place until very late in the course.

6. As a rule, engineering courses are too narrow, hence they should be broadened by teaching much more of the "humanities," in the modern acceptance of that term, than is now customary.

7. All American technical students should be taught to read, write, and speak the English language thoroughly and well.

8. An effective course in Public Speaking should be given as an obligatory course in every technical school.

9. A thorough course should be given in general economics and another in engineering economics. The latter subject should also be elaborately treated in detail by the instructor in each engineering specialty.

10. Practical courses should be given on "Business" to include such matters as accounting, business law, finance, and general business principles.

11. Special attention should be paid by each instructor to the attributes of neatness, accuracy, and system; and these important desiderata should influence the recorded standing of each student.

12. All engineering students should be taught free hand sketching as done in the leading architectural and military schools of this country.

13. The faculty in each engineering school should, by concerted action, evolve and put in practice a scheme for developing clear thinking, vision, and breadth of view in both the teachers and their pupils.

14. All teachers should inculcate in their students a true love for their work; but in order to accomplish this they must do likewise for themselves.

15. At the very beginning of their freshman year, engineering students should be given a series of lectures concerning the character, functions, extent and greatness of the engineering profession; and this information should be repeated to them incidentally by the members of the Faculty from time to time during the entire extent of the course.

16. The time now spent by engineering students on outside activities and social functions is much too great. It should be reduced as soon as practicable to the proper minimum.

ADEQUATE COMPENSATION FOR ENGINEERS

Of all the learned professions the members of the engineering profession are most underpaid, and it is the one profession that today does least for its members to remedy this evil. This is aptly illustrated by the recent action of the American Engineering Council. This organization not only has gone on record endorsing the Graham bill for increasing the salaries of federal judges, now before Congress, but is actively supporting the bill. No one questions the justice or equity of increasing the salaries of federal judges. They are underpaid when compared with the average salary schedule of the legal profession nor do we wish to criticise the American Engineering Council in this matter; in fact we commend it for its attitude. But what about the engineers who are underpaid? Has the American Engineering Council shown the same solicitude toward their predicament, or has it advocated any plan or campaign of education to raise the schedule of salaries of engineers? Is the average engineer in a more favored position today than the lawyer? Is it not true that the average schedule of fees in the legal profession is far above that in the engineering profession, and is it not a fact that the average schedule of salaries paid to lawyers and jurists is far above the average schedule of salaries paid to engineers?

It is argued that the increase of salaries to federal judges has not been in proportion to the increase in the cost of living. Has it been so in the engineering profession? There are today scores of engineers underpaid to every lawyer who is underpaid for his services.

The fact that the legal profession can get engineers not only to endorse their program for salary increases but also to work actively in their behalf is evidence that the lawyers are looking after the welfare of the members of their own profession. However, charity begins at home and it might be well for engineers to take a leaf out of the book of the lawyers and begin to do something for the members of their own profession who are woefully underpaid.

The American Association of Engineers has in the past taken up the battle of adequate compensation for railroad engineers and for the municipal engineers of seven of our larger cities and has helped them secure substantial increases. The association stands today definitely com-

mitted to a policy of adequate compensation for engineers of all branches of the profession. It is the only engineering organization that has so far taken a definite stand in this direction. Much can be accomplished by proper publicity, educating the public, and by co-operation among engineers. It is hoped that engineers the country over will give their active support to this work of A. A. E. in trying to better the financial status of engineers who are today underpaid.

WHY IS A CONTRACTOR?

(Authorship of the following is ascribed to Mr. F. L. Shidler, President of the Shidler Contracting Co., Kankakee, Ill.; Men have achieved immortality for less worthy labors. —Editor.)

"Don't try to make any money in your business.
You should be satisfied with the work and worry.
—That should be reward enough.

Talk about your "wonderful rainbows" until you believe it yourself.
Invest all your capital and as much more as you can beg, borrow or steal.
Don't figure interest or profit.
—That's old stuff. Not done now.

Show your fellow-contractors that they have not been taking work at actual cost or below.
Bid the job a-w-a-y d-o-w-n! Show them that YOU THINK that the actual cost (or less)—Is 'way tahel-angone below their bid figure.
The proper time to show up your fellow contractor is on the
First jobs that come up each year.

Later in the season you might not have as large an audience.
If you *know* you're losing money on your work get
Another job at still Lower Price.

Lap the second job into the first one.
—It may keep you from going crazy until a later date.
This method also helps as a Smoke Screen to fool yourself, your
Backer, bankers and material and equipment men.

Don't figure in "Overhead" or "Traveling" expense.
There ain't no such animals. Don't figure in "Depreciation."
—It's too damn big a word to be understood in contracting.

Never admit to yourself—or anyone else that if you did fifty
Percent of a certain volume at a Reasonable Price you would make
More real money than to do twice as much at No Profit.

Always be mentally and physically fit to be able to laugh off
Such things as Delayed Estimates, Call Loans from Banks, Material
Shortages, Payrolls and Freight Bills; Break-downs, Rain and
More Rain, Strikes and Long Hauls; Hot Weather and Dry Weather,
"Pleasant Inspectors" and Cement Overrun; Low Grade, Water Short, age, and Accidents; Shut-downs and Long Hours, Etc., etc., etc.

Always treat your fellow-contractor friendly to his face.
Then stick your knife in the left side rear.
—you can reach his heart best at that point.

If you are "second" or worse at a letting slip around to the powers
That be. Tell them you made an error and if the job is relet you
Will bid lower.—Manage somehow to create dissension!

Aim to attend all contractors' meetings. Say as little as you
Can yourself, but get all the information you can about your
Competitor's business. If you are asked to talk about your work,
—Duck the issue!

Never buy of the material man who went along with you on the bid.
Tell him he is "out of luck." Buy from the fellow who was riding
With the other bidder.—His man lost, so you're his meat.

Never get well acquainted with your competitors, or put your cards on the table with them.
—They might be bigger and better fellows than you thought.

Don't be satisfied with enough work to start the season at a
Decent price. Fill up on work 'till it runs out your ears.
—At any old price.

Contracting statistics show that ninety-
five per cent of contractors go broke.
—Don't break the rule by lowering the
percentage.

Don't let a little thing like the future of
the wife and kids
Bother you. The States and Counties
have provided institutions
For their care.—Or your wife can get
out and get a job
—If you should kick off.

Abide by these standards. Pep up the
industry and create a
Vacancy for other damn fools as they
come along.

PLAYGROUND BEAUTIFICATION AWARDS

The three highest awards of the Harmon Foundation in the playground beautification contest among 189 communities have been won by Green Bay, Wisconsin, La Porte, Indiana, and Stillman Valley, Illinois, according to the Playground and Recreation Association of America which conducted the contest.

The Green Bay Park Commission, the La Porte Board of Education, and the Stillman Valley Community Recreation Association which sponsored the playgrounds taking first place will each receive $500 in cash from the Harmon Foundation and $50 in nursery stock from cooperating nursery companies. Thirty other communities ranging in population from 800 to 169,000 will receive smaller awards of $50 in cash and $50 in nursery stock.

The awards were based not on the final beauty of the playgrounds but on the progress in beautification during the period of the competition. It was the intent of the donors of the awards not simply to reward communities for having beautiful playgrounds but rather to encourage the movement for permanent beautification of the places where children and adults play. As the judges stated in announcing their decision: "There are very few of the competing playgrounds which do not offer many possibilities for still further improvement." Yet remarkable results were achieved in numerous cases, as photographs and the testimony of eye witnesses have revealed.

In the numerous local campaigns for beautification, a great deal of community cooperation was inspired, according to the judges. In La Porte, for instance, schools, clubs, business organizations and individuals responded to the call for donations to plant trees or furnish equipment or actually to perform manual labor. The Business Girls' Association gave swings. The Kiwanis Club held a benefit baseball game, from the proceeds of which they donated other equipment. School janitors mowed the grounds and cultivated the trees. With the exception of the fence, which was built by the Board of Education, every dollar's worth of improvement was made with private funds.

The by-products of the contest are as notable as the direct results in beautification. In Stamford, Conn., practical lessons in civics were held on the playground. Classes studying this subject in the three schools near the playground visited Hyland field with their teachers and there talked and studied the planting and all that it stands for. The interest aroused by developing the play field in Bellefontaine, Ohio, led to two new playgrounds, one set aside by the city council and one purchased by a church. A year-round director of recreation has been employed.

American Legion posts, women's clubs, school boards, park commissions, civic clubs, Parent Teacher Associations, commercial clubs, recreation commissions and departments, Lions Clubs, and other groups sponsored the 321 playgrounds entered in the competition. Thousands of children had a personal part in clearing the fields, constructing buildings, and planting trees, vines, shrubs and flowers. The wide-spread participation of so many groups in so many communities and the encouraging results obtained, inspire in the sponsors of the contest the hope that the quality of beauty, as well as of efficiency, will hereafter generally be expected in public playgrounds in American cities.

THE RAILWAY AND THE CITY PLAN

By C. F. Loweth, Chief Engineer, C. M. & St. P. Ry., Chicago, Ill.

(Paper before 18th National Conference on City Planning, Jacksonville, Fla.)

The railroad is a fundamental element in a city plan since its location has an influence upon the city's growth, but this interdependence between the railroad and

Co-operation between city planning officials and railways with respect to zoning is highly desirable, but to be efficient it should be before there is a commitment on the part of city authorities. One large manufacturing city in the Middle West has recently committed itself to a plan of converting its small water courses into parkways. Along several of these are railroads, and more or less of the adjacent property is used for industrial purposes. If the plan is not abandoned, it seems certain that industrial development will be checked immediately, followed by a decline of such as now exists. The city will become the possessor of parkways along natural streams bordered by railways and will in time have sacrificed large industrial possibilities when it might have created equally adequate and satisfactory parkways elsewhere.

The city plan looks toward an improvement in the attractiveness of the city. Here is an opportunity for greater co-operation between railroads and city and town authorities in making the right-of-way, station grounds, and structures of the railway more attractive; but, this effort will be of little worth unless the authorities can bring about similar improvements in the vicinity.

The attitude of the railroads to city planning is influenced by the financial contributions they may be called upon to bear. There is no shame-facedness in this admission. It is equally true of the citizens and of local industries and commercial interests, but the railroads are not as well able to protect themselves against unreasonable and unfair demands; for they are liable to various reprisals when they oppose local interests.

Municipal improvements are paid for generally by assessment according to benefits. This method is liable to error and abuse in which the larger corporations, particularly railroads, suffer. A recent regional planning association report states that its parkways are to be paid for by assessments according to benefits; it then goes on to explain that these benefits will extend great distances and include many hundreds of property owners, but that the cost of collecting many small assessments would be prohibitive and the district assumed to be benefited would therefore be restricted. As railroads border several of these proposed parkways it seems certain they will be expected to pay unduly. This will be the more unjust as the proximity of these improvements, as with many others, will be a liability in that they will call for other more or less incidental and expensive improvements. Assessments against residence property may be very large, approximating confiscation, and yet greatly enhance its value for other purposes. The owner is therefore the gainer. But, railroads can use their property for no other purpose nor can they move away. If the railroads are given equal consideration and fair treatment in this very practical and important matter of financial liability for city and regional improvements, it will be found that they will fall in line with the plans of the authorities, at least equally with other local interests insofar as they may be able.

AN EXAMPLE OF POLITICS IN ROAD BUILDING

(Editorial in New York Herald-Tribune)

A piece of political jobbery has just been perpetrated in New Jersey, in the changing of the personnel of the State Highway Commission. That body consists of four members, two of them being from each of the two parties. For four years it has been doing admirable work, as all are agreed, without suspicion of political partiality or patronage. The best interests of the state would be served by its continuation in its present form.

The state, moreover, is on the point of beginning a system of road building which will involve the expenditure of from $160,000,000 to $200,000,000 in the next half dozen years; wherefore there are the strongest of additional reasons for keeping politics out of the commission and keeping in it men of experience and technical knowledge.

Yet Governor Moore has just declined to reappoint a member who is a practical engineer and who is generally recognized as of exceptional value to the commission and to the state, and has appointed in his place an estimable druggist, who has no experience or special knowledge of road building, but who is regarded as an adroit and efficient "practical politician."

Both the retiring commissioner and the new appointee are Republicans, so that the governor has not broken the bipartisan rule. But he has for the first time injected politics into the commission. It is understood that he made the new appointment at the request of certain Republican leaders, who were afraid that Frank Hague would have the Democratic members gobble up all the patronage for that party if they did not have a more active and aggressive Republican on the commission to grab a goodly share of it for his deserving friends.

Thus notice is practically served upon the state that its big appropriation of $160,000,000 or more is to be administered primarily for the benefit of the politicians and only secondarily in the interest of the people.

RAILWAYS ADOPT WATER-CEMENT RATIO LAW

The American Railway Engineering Association officially adopted a specification for proportioning concrete based on the water-cement ratio law of strength at its annual convention at the Palmer House, Chicago, March 10. This specification was prepared and presented for adoption by the Association's Masonry Committee, of which C. C. Westfall, Bridge Engineer of the Illinois Central Railroad, is Chairman, and Job Tuthill, Assistant Chief Engineer of the Pere Marquette Railway, is Vice-Chairman.

The adoption of this specification by the American Railway Engineering Association marks the abandonment of the 1:2:4 and other arbitrary mixes that have been in use for many years. Instead, the ratio of water to cement is specified, and the proportions of sand and stone are largely left to the discretion of the individual engineer. According to this law, the strength of concrete, within the limits of plastic, workable mixes, is inversely proportional to the amount of water used. By applying this law, engineers can secure concrete of a specified strength within given limits.

This specification, by its adoption on March 10, will become recommended standard practice for all railroads in the United States and Canada and will appear in the Association's Manual of Recommended Practice.

A new specification for portland cement was also accepted. This specification was recently adopted by the American Society for Testing Materials and was prepared by Committee C-1 of that Society. C. C. Westfall, J. J. Yates and M. Hirschthal, who are members of this Committee, also belong to the Masonry Committee of the American Railway Engineering Association.

THE PAY-AS-YOU-GO MYTH

By Thomas H. MacDonald, Chief, U. S. Bureau of Public Roads, Washington, D. C.

There has been much talk about the pay-as-you-go policy. This policy is a myth. It does not exist in any state where there has been any considerable mileage of the higher type roadways built. It is true that some states have not issued bonds, but their counties have issued the bonds and have loaned the proceeds to the states, or have built the roads on the state system. There is not a single exception to this rule. In fact, there is only one state which has not issued either state or county bonds. Iowa, for example, has issued no state bonds as such, but within the last few months five or six counties have issued upwards of $6,000,000 in county bonds, which will be expended by the state and amortized from the state's income from the motor vehicle. Thus, while the bonds are technically not state bonds, in fact they are state bonds, but county credit in place of state credit has been used to float them; a much less satisfactory and more expensive procedure than to issue state bonds outright. It is true that in recent years the state of Virginia has not issued state bonds, but the figures for 1925 show more than $2,600,000 transferred from the counties to the state, much of which was derived from county bond issues and used by the state for state road purposes.

In no state is the income from the motor vehicle licenses and the gas taxes sufficient to maintain the highways of the state system and to provide current funds sufficiently large to make any considerable progress in the building of the higher types of roads on the so-called pay-as-you-go policy.

ARGUMENT FAVORING COMMISSION-MANAGER GOVERNMENT FOR INDIANAPOLIS

By J. W. Esterline, President Esterline-Angus Co., Indianapolis.

(Editor's Note: An election will be held in Indianapolis in June to enable the voters to pass on the adoption or rejection of the commission-manager form of government for this city. A vigorous campaign on the issue is now under way. Mr. Esterline is one of the foremost champions of the proposed form of government and in the following address he develops the best case yet made in favor of this proposal. He spoke before the Indianapolis Rotary Club.)

The question before us today is one of government, not of politics. The proposal to place this city under the manager plan is not an attack on any party, or any administration, or any group of individuals. It is based on the principle that the management of a city is a business proposition, and that as such it should be taken out of the field of political controversy.

City manager government means nothing more nor less than the application in city government of the same principles and processes which are successfully employed in the management of private corporations.

There is nothing new or untried about this system. While partisan government has been making a miserable failure in our American cities, in private business the manager system has made us the most prosperous people on earth.

What could be more logical and more sensible than to replace a scheme which has failed in our municipalities with the plan which has been so successful in our private corporations?

Only Four Drop Plan

Twenty years ago American cities began the adoption of the nonpartisan, commission-manager form of government. Today 360 cities and towns are operating under it. It has proven so far superior to the party system that with the exception of four small towns no city having once adopted it has gone back to the old plan.

Representative government must express the will of the majority; it is something more than simply government by representatives. Ability of the people to direct and control officers after they are elected is more important than the privilege of electing them. Most people seem to believe that democracy consists solely in the right of every citizen to vote and to hold office. There is another privilege guaranteed by true democratic government, which is just as important as the right of suffrage. It is the right of the people to determine the form and nature of their government.

No man can study the development of representative government, without recognizing that only by the exercise of this fundamental right to adapt government to their changing needs, have free peoples been able to preserve and perpetuate democracy itself.

Ever since democratic government was first instituted in this country there has been a constant conflict between the people, on the one hand, seeking to secure for themselves government which is responsive to the popular will, and on the other selfish unpatriotic men and interests, attempting to turn the affairs of government to their own advantage. Almost without number are those occasions on which the people have been driven to the necessity of inventing new plans, forms and methods, in their efforts to thwart the plans of a self-seeking minority.

What, in our own day, has made necessary such innovations as the direct primary, the publication of campaign expenses, the resignation of lobbyists, and administration by non-partisan commissions? These are but efforts of the people to defeat the ulterior designs of that class which has always been willing to scuttle the ship of state for their own personal aggrandizement.

Is Now Necessity

The city manager plan of municipal government is simply another invention of honest citizenship, born out of necessity, in order to stay the hand of professional politics, operating on the principle that "To the victor belongs the spoils."

Will any one question the right of a majority of the citizens of this or any other city to insist upon a modification of their form of government, if thereby the ends of government will be assured?

And I submit to you that it is nothing short of cowardice for us to pass on to the coming generation the problems which should be solved by us here and now. No one knows what are the crises those who come after us will be called upon to meet, but the question we must

answer is this: Are we brave enough to face squarely the issues which confront us, or are we such cowards as to pass on to our children, unmet and unsolved, the problems of our day and time?

There is general agreement among men who read and think, that if there is any one thing which should now engage the minds of men in this country, it is the problem of municipal administration. It is that part of government which comes nearest to the lives of a majority of our people. In it are involved the health, the safety and the material prosperity of more than half of our population. In the city the majority of the coming generation get their ideals of government. It is in the cities we are making the most dismal failure. If democracy is to succeed and live in America it must succeed in the cities. If it fails, it will be the result of our failure in the cities.

It has been frequently asserted in the press and on the platform, that the failure of municipal government in this country is not due to the system we have, but rather to the type of men we put in office and to the apathy of the voting public. I expect to prove to you that the kind of men we elect to municipal offices and the disinterest of the public are the inevitable result of our adherence to a system of election and administration which is so weak as to be absolutely unequal to the task it is intended to perform.

Many Good Officials

I am not one of those who are so ready to attack and condemn men, when it is the policies of government which are at fault. We have had, and have today many conscientious men as city officials. Some of the members of this club have worked long and hard to serve this city under a system which, by its own record, stands condemned from one end of the land to the other. They themselves express dissatisfaction over the little they were able to accomplish.

The aldermanic or Federal system was instituted in the days when towns were small, the people comparatively poor and the work to be done relatively simple. In those days the function of city government was largely legislative, while executive and administrative problems were few and less important.

Today 56 per cent of our people live in the cities, which represent great concentrations of population and wealth. The legislative work is now almost insignificant when compared with the problems of administration. Because in the days of the town meeting, a few citizens chosen at random could pass the laws necessary to keep the children in school and the cows off the streets, we foolishly expect that we can by the same process today, select from all walks of life, men who can cope with great engineering and administrative projects, requiring the rarest of judgment and foresight. Investigate the cities of Indiana and you will find barbers strugging with problems of finance involving millions, bankers confronted with great engineering projects, lawyers dabbling in sanitation, and men who don't know the difference between concrete and convulsions, trying to execute public work. Honest men, most of them, but called upon to handle problems with which they are not familiar, and many of them carrying responseibilities which are away beyond their capacities.

Appointment Is Best

Now the system is at fault because of the manner in which we create all these misfits in office. You can elect legislators, but good administrators must be selected. Legislation is a process of integration, the summing up of the work of many minds. Administration is just the reverse, requiring the concentration in one mind of definite authority and responsibility. Because of the number, you can take some risk in electing legislators, but you must not take chances by electing administrators.

No financial house or industrial company with a large number of stockholders would risk placing incompetent men in important administrative positions, by allowing the stockholders to elect them. Their selection is always left to the board of directors. Men who have been elected to public offices can not be removed if they prove incompetent; but men who are selected and employed can be discharged.

I come now to the second weakness of the present system. Consider the task which the present method of filling the various municipal offices imposes upon the citizens, who is admonished to do his duty by electing good men. Obviously each citizen should obtain his information before the primaries, when there are several candidates for each of the numerous offices to be filled. What are the sources of reliable information regarding the character and qualifications of a long list of candidates? The men recom-

mended by one newspaper we find condemned in another.

Few Know Candidates

Tell me, if you will, how 100,000 voters are going to get unbiased information concerning the qualifications of eighty or ninety candidates in a few weeks? Why, if a man had nothing else to do between the closing of nominations and the primary elections, it would be an impossible task. How many of you know what you are expected to know about the men you voted for in the last city primary? If you had not the means of knowing, how about the folks who have less opportunity to get information than you have? I have seen the board of directors of a private corporation spend three months selecting one man for a position which would not begin to compare in importance with one of our city departments, yet we expect busy citizens to decide upon all their officials in five weeks. The long ballot is what makes the political slate succeed. Just so long as we confront the voter with a long list of candidates to be voted for, incompetent men are going to be swept into power.

The third glaring weakness of the Federal system is its temporary character. If the mayor-Council form will succeed anywhere, it should succeed under the Indianapolis charter, because it is one of the best of its kind. I shall show you, however, that the rigid safety measures which are necessary under partisan municipal government, have rendered it well-nigh inoperative.

One of these safety provisions is the limitation to tenure of office. In order to prevent one party from capturing the city permanently a change of personnel is required every four years.

It makes no difference how good an administration the citizens elect, it is automatically retired at the end of four years. The reason the city is being run by amateurs all the time is because, as a necessary safeguard, we tear our city organization to pieces every quadrennium. No institution can undergo frequent disruptions of this kind and be successful. I want you to consider also the effect of these frequent changes on the interest and morale of our municipal employes. Due to the wide use of political patronage, rewarding those who have helped to win the election, all realize the temporary character of their positions, with consequent lack of interest and loyalty.

Remember also that these frequent and complete changes of personnel in all departments eliminate all possibility of anything like a continuing plan or policy. How foolish we are to expect that on a given day all those who have had experience in the management of the city can step out and a new organization come in and make a success of it. Worse than that, we frequenty have seen the spectacle of the outgoing administration doing their utmost to make more difficult the work of their successors. Before I am through I am going to give you evidence that city manager cities are looking from twenty to fifty years ahead in their plans, and that under competent leadership, with business-like methods, they have created high-grade, honest, capable organizations which deserve to be continued, because they are responsive to the public will and are rendering the people service, something which is impossible under the partisan system.

Authority Divided

The fourth reason why the Federal system has failed is because it provides two heads, with divided authority and responsibility. In this double-headed government the mayor is vested with the appointive and administrative duties, and the council with the legislative and appropriating power. This is another example of the necessity, under partisan government, of sacrificing efficiency in order to provide safety.

This is called the principle of "checks and balances." The theory is that neither department has the power to go very far in opposition to the other. A competent, able, honest mayor and an equally able and conscientious Council can get something done, provided they agree. Either can check the other if they are not in agreement. It is equally true that an incompetent and dishonest mayor and Council can loot a city if they choose. Now, how does the principle actually work out?

In cities where both mayor and Council are crooked or controlled, the people get robbed. When one department is straight and the other is crooked, they get nowhere. Just because of the uncertain way we have of selecting our chauffeur, we have made our municipal motor car all brakes and no motive power. We have set the brakes and taken out the spark plugs, to keep the boys from running it on the rocks. It is safe, perhaps, but it gets no place.

Few Able Men Run

The fifth cause of the failure of the partisan system is the reluctance of able men to serve under it. How frequently we hear the assertion that if the people would just elect good men to office our troubles would be over. Have the men and the newspapers, who make that assertion, ever taken the pains to find out why better men refuse to seek municipal offices? Such an investigation would show that it is not the fault of the people, nor the men who could manage the city, but that it is because an outfit geared up in such a manner that none but politically minded men can run it. Politics will not work in business, and business does not go in politics.

If one-half of the cities in this country were getting decent government under the mayor-council system, there would be some ground for concluding that the fault in the other 50 per cent was due to the inability or unwillingness of the people to choose the right sort of officials, but when the scheme is making a miserable failure in a large majority of our municipalities, we are forced to conclude that the fault is inherent in the system itself.

There are six very pertinent reasons why you rarely find able men and women serving under the aldermanic system, and let me tell you what they are.

The first reason is that a sef-respecting citizen refuses to compromise himself by making pre-election deals with professional politicians, in order to be elected.

Second Reason

The second reason is that the ablest man we have in Indianapolis has no assurance that he could accomplish much for the city, if elected, because of the divided responsibility in the work of administration. Take for example the College avenue bridge. The men on the board of public works have to rely on an engineer appointed by and responsible to the mayor and look for the funds from a Council elected by the people, and you have seen how it was necessary to turn the bridge over to the park board because your mayor and the business men on the board of works had their hands tied.

The third reason is that men know that even if elected and enabled to create an efficient organization, the whole thing is temporary. In four years the whole job must be done over again.

The fourth reason is that able executives do not do their work the way our mayors and councilmen are required to do it. Instead of passing on every detail himself, when a business man wants to get something done, he employs experienced men and holds them responsible for results. You can make up your mind right now that you are not going to get men of ability to leave their business and spend all their time on details which can be handled better by some one they can employ.

The fifth reason is that a man who has an ounce of brains knows that there never was, is not now and never will be anything akin to loyalty, morale or interest on the part of employes where merit is not recognized, and where the job has not the element of permanence. Your able citizen insists on having an organization which is loyal and interested in its work.

Petty Interferences

The sixth reason is that men do not care to subject themselves to the small, petty, partisan interferences and political pressure which is brought to bear upon office holders under the partisan system.

If you will create the conditions under which the best of your citizenship can make its contribution to the welfare of the city, they will respond. We see them in co-operation on the boards of the Community Fund, the Chamber of Commerce, the Boy Scouts, the hospitals, the Y. M. and the Y. W. C. A., the colleges and a host of other public enterprises, but you will never get the best that Indianapolis men and women can give the city until and unless you create the conditions under which capable and self-respecting citizens can work. Five bankers constitute the Council in Miami, Fla.; Cincinnati has a Council of able citizens, but these cities could not command the time and ability of such men until they gave up the partisan system.

And now I come to the reason, above all others, why municipal affairs should be divorced from politics. In spite of the fact that there is no Democratic or Republican method of paving a street or operating a police department, the industries and citizens of Indianapolis are paying a tremendous price for the maintenance of a political organization which is serving no good purpose.

How much longer shall we submit to excessive taxation, lax law enforcement, expensive public work and indifferent city government, for the sake of main-

taining a political machine which can throw its full quota of job holding voters back of preferred candidates in every city, county, state and national election?

Politics Opposes Plan

When city manager government was proposed for Indianapolis two years ago, why was it we drew the fire of partisan newspapers all over the state? Why did the recent Legislature, while neglecting many important measures, look carefully after the fortunes of political groups in Indianapolis, Evansville and New Albany? Why are both Republican and Democratic leaders now forming organizations in this city for the alleged purpose of promoting clean government? For no other reason than the fact that the city manager movement promises to destroy in these cities three units of a state-wide political machine, which is maintained in the cities of Indiana at a tremendous expense to the citizens of those cities.

My friends, I have no quarrel with political parties, and I care not how thoroughly they organize, but I do protest with all the strength that is in me against these organizations being permitted to perpetuate themselves by demoralizing and debauching the government which is charged with the preservation of our health, our property and our lives. I do not know how you feel about it, but I am tired of paying high taxes for the privilege of dodging chuck holes, and of seeing the Legislature manhandled by professional politics from machine-ridden cities.

There is a very commendable effort being made to promote the development of Indianapolis, and I can not do justice to my subject without calling your attention to the relation between good government and city development.

City's Liabilities

Is there any reason why a municipal corporation should be judged by any different standards than a private one? When you want to borrow money your banker insists on knowing your liabilities as well as your assets. I have heard a number of "Indianapolis First" addresses recently, some of them by bankers, and every one of them has been a recital of our municipal assets, ignoring entirely the fact that balanced against these are some heavy liabilities which must be liquidated.

Yes, we have the transportation, the parks, the native-born citizens and the rich country surrounding us and all that. But on the other side of the ledger we have a high tax rate, much work that should be done held up by disagreement and dissension, and a very general and perhaps well-founded conviction in the minds of our people that many things which are going on would not stand the light of day.

I know from experience that worth while industries seeking locations, check up on the drawbacks of a city, as well as its advantages. While the officers are getting the bright side of things from the Chamber of Commerce, their engineers and personnel men are quietly checking up on the things the Chamber of Commerce dares not mention. I know what I am talking about, and I can name you some Indiana cities which failed to get important industries they were after because of such things as low civic spirit, bad moral conditions, lax law enforcement, neglected public improvements, etc. Whenever an engineer finds a city about which the suburbs are incorporating as separate towns, resisting to the last ditch being absorbed into the city corporation, it is considered competent evidence that people know the liabilities of the city overbalance its assets.

Eyes Must Be Open

I am a member of the Chamber of Commerce and expect to remain a member, but I am not one of those who evidently believe that by shutting our own eyes to our liabilities we are going to fool men who have their eyes open. The cities which have up-to-date government have pride in it and believe me they are broadcasting it and capitalizing it to the fullest degree. If we have not the foresight to see it now, sheer competition will bring us to our senses later. The situation is really serious, and it is going to take something besides a high school pep session to cure it.

For a good number of years it was my business, as an engineer, to examine the internal organization of many industrial corporations which were suffering from bad management. One of the most damning things we found in such organizations was internal politics, resulting from indefinite fixing of authority and responsibility.

Now, let me show you the organization chart of the city as it is intended to be in its purity under our charter.

The people are expected to be supreme, and having chosen their mayor

and Council, it is innocently supposed that the government will be responsive to the public will. Why should it be? They are in for four years regardless of the people. They have to get out at the end of four years, regardless of their record.

Groups Gain Control

But in recent years professional politics has added a refinement in municipal government, which is not contemplated in the charter of any city. The enormous sums which our large cities spend, the great number of people they employ and that element of society which is willing to pay for the privilege of violating the laws have made possible in our larger cities a well financed organization which has stepped in and taken the place of the people, so that our organization diagram looks like this:

Here you find the reason why partisan government is not responsive to public will. Machine politics is diametrically opposed to governments by the majority. It is government by an organized minority which depends for its success at the polls upon keeping the majority well divided, while it remains cohesive.

Do you wonder that there is waste and extravagance in a corporation having an organization chart like that? Do you see now why men who know something about management are reluctant to accept office under this system? The way for honest citizenship to free itself from machine politics is to unite on a nonpartisan basis and set up a city government which is beyond the reach of political control.

The city of Indianapolis is a corporation with perhaps one hundred and fifty thousand stockholders, and assets aggregating at taxable valuation three quarters of a billion. Every year these stockholders pay into the treasury millions of dollars to finance the operations of the civil city. Ninety-five per cent of these stockholders all want the same thing, honest, efficient, intelligent management. Why in the name of common sense do we permit ourselves to be divided into two opposing camps, and have a contest every four years to see which of two inexperienced groups will work for us during the next four?

United Action Needed

We all pay taxes into the same treasury; we all use the same streets and parks; we all want the fires put out and the thugs put in jail. Why cannot we all get together and create an organization which can get things done and which is worthy to be continued? It is time in municipal affairs to quit talking about the good of the party, and think about the good of Indianapolis.

America has led the world in the development of corporate management, and the only thing which has prevented the application of correct principles of organization and management to our municipalities is the false idea that people who work and serve and cooperate in private business can not do the same thing in public affairs. The men who say it can not be done are those who do not want it done. Three hundred and sixty cities and towns in thirty-six states have proven that it can be done.

I want next to show you the type of organization used by practically all private corporations. The first in authority are the stockholders, who elect the board of directors, who fix the policies and select the administrative officer. The general manager selects his department heads, and they the employes of their respective departments. This represents the best that business experience and ingenuity has been able to devise.

Citizens Elect Board

Now, compare this with the chart of the city manager plan of municipal administration. The citizens, who are the stockholders, elect on a nonpartisan ballot a board of commissioners.

These commissioners govern the city, they fix the policies and select, employ, supervise and control, with right to remove, a city manager; a full time, experienced, well-paid nonpoitical executive who appoints, supervises and controls all department heads, who in turn control the employes of their respective departments.

The city manager is chosen with respect to his experience and record. The commissioners can go anywhere in the country for him and pay the salary necessary to get the man they want. They can remove him at will. The manager employs the department heads and holds them responsible for results. Positions under these department heads, the employes of departments are selected by examination and promoted on the basis of merit.

City management has become a profession in America. City managers have their national organization, magazine and annual convention. Today some of the best men coming out of our technical

schools are entering the city manager profession, taking positions in the smaller cities, as the older and more experienced men are called to larger fields.

You see at once that this plan of organization is identical with the system which intelligent men use in business organizations, and you will find that it has strength at every important point where the political system is weak. The commissioners are elected by ballot, and as representatives of the people are final in authority.

Seven Chosen First

At the first commissioner election seven men are chosen. In two years four are elected; two years later three retire, and so on. This makes for stability, a continuing policy and enables the voter to choose a small number intelligently.

The administrative department of the government has the element of permanence, so long as it deserves to be permanent. You all know that experience, accumulated skill, morale and interest on the part of employes, come from the recognition of merit, fair dealing, absence of favoritism and a steady position, instead of a temporary job.

The work is done by men experienced in their respective lines, and it is possible to attract good men to permanent positions, where a man's tenure depends upon his ability.

Responsibility is fixed and definite; men must produce results or get out; there is no opportunity to evade responsibility.

Cities under this plan find it possible to get able men to serve as commissioners. If you are skeptical on this point, note carefully the telegrams I shall read to you.

Replies Praise Plan

If I have told you the truth, the experience of cities having manager government will support the statements I have made. A few days ago I sent telegrams to the presidents of the Rotary clubs in the larger cities which are governed under the manager plan, asking for a frank expression on the operation of the system in their respective cities.

Replies from presidents of fourteen Rotary clubs were received and presented by Mr. Esterline, as follows: George A. Phillips, Columbus, Ga., population, 31,125; John Vanderwerp, Muskegon, Mich., population 36,570; G. F. Loomis, Kenosha, Wis., population, 40,472; H. E. Dunlap, Wheeling, W. Va., population 56,208; Ralph B. Redfern, Portland, Me., population, 69,272; Joseph H. Stephens, Sacramento, Cal., population, 65,908; W. C. Coleman, Wichita, Kans., population, 72,217; William Whaley, Knoxville, Tenn., population, 77,818; Clayton S. Cooper, Miami Beach, Fla., population, 89,971; Sam Ross McElreath, Fort Worth, Tex., population, 106,482; W. W. Houston, Norfolk, Va., population, 115,777; Horace M. Huffman, Dayton, Ohio, population, 152,559; Fred Sowers, Cleveland, Ohio, population, 796,841; William Light, Cincinnati, Ohio, population, 401,247. Each of the messages contained praise for and satisfaction with the city manager form of government.

Need I give you further evidence? If so, I have before me here fifty similar telegrams from the chambers of commerce of the larger of the 360 cities which have adopted manager government.

When this subject was brought before the people of Indianapolis two years ago, the advocates of the political system raised a question regarding the adequacy of the Indiana city manager law. You will recall perhaps by whom these adverse opinions were given. These gentlemen admitted the superiority of the manager system, but argued that our Indiana statute was a hastily drawn and poorly conceived instrument under which to administer the affairs of a city like Indianapolis.

With but two exceptions these criticisms were made by lawyers who were at that time or who recently had been candidates for office. The remaining two were respectively the father-in-law of a candidate and the venerable author of our present charter, which, by the way, has been amended seventy-nine times since it was adopted. Evidently these men were ignorant of the fact that there are ninety-three cities and towns under city managers in states that as yet have no law at all on the subject.

But brushing aside the fact that personal interest may have colored the views of these gentlemen, and giving credence to sincerity of purpose on the part of those making these criticisms, I have before me here signed opinions of a number of eminent lawyers of this city, men whose names are known throughout the state and whose opinions carry great weight.

Find Law Adequate

These authorities on the subject of

law, such men as the late Judge E. W. Felt, John W. Holtzman, Henry M. Dowling and Rappaport, Kipp & Lieber, after a careful study of the statute have said to the citizens of Indianapolis and of the state that the city manager law of Indiana is entirely adequate, and that they can find no basis for the assertion that a successful city manager government can not be conducted under it.

Finding that they have failed to deceive the people by the smoke screen thrown up concerning the law, I predict that you will hear something like this in the days that are ahead: "It is unsafe to put so much power in the hands of one man."

Talk about power! There are men in the machine-ridden cities of this country who have vastly more power than any city manager. And what is more, they can not be removed by the majority vote of seven commissioners.

Then, too, our opponents will tell you, "There is danger that the people will rise up and adopt this new system, and go back to their work thinking everything is settled, and the political crowd will step in and have a better chance to control the city than they now have."

It is really wonderful how solicitous the political group is for our welfare. If the city manager plan really gives a better chance to control the city, why are they opposing it so strenuously? They have supported every other scheme designed to tighten their grip on our city affairs, so why are they opposing this, if it gives them just the opportunity they are looking for?

The bitterest opponents of the manager plan are those who in some manner, either directly or indirectly, are obtaining personal advantage or benefit by reason of the inefficiency of the present system.

Enemies are Victims

The bitterest enemies of the present plan are the citizens who are the victims of its inefficiency.

The strongest advocates of the manager plan are the citizens of the cities which have adopted it.

I challenge our opponents to name a single city in which professional politicians have ever been able to regain control once a good city manager has been selected and given an opportunity to show the people what efficient government is like. The fact that the people do and will support good government, once they see it demonstrated, is the most heartening thing of it all.

Last spring the City Club of Chicago sent Dr. Leonard D. White, professor of political science of the University of Chicago, on a tour of the forty largest cities having city manager government.

I want to quote from his report which was given at a dinner of the club on the evening of December 3, 1926:

"Last spring I was designated by the university to make an objective study of the council-manager plan. I put in five months and traveled 10,000 miles, visiting forty towns among the 360 municipalities, which have the council-manager plan. In each I talked not only with the city manager and the friends of the plan, but with the opponents. I talked with bankers, business men, labor leaders, editors. I feel, as I come back, that I at least have a practical understanding (1) of the way the plan is going, and (2) of the attitudes people are taking toward it.

Cleveland a Success

"Cleveland has experimented a notable success. When William R. Hopkins became city manager there was an obvious change. He has followed what I found to be the universal trait of city managers, complete and undivided loyalty to the interests of the city.

"I have found that almost without exception the city managers insist day in and day out that they will not play politics. They will give up their job before they will do that."

I grant you that it would be unwise to adopt this plan and then turn the election of the first commissioners over to the political crowd. Results are what create and hold public support and this plan of government must remain in hands favorable to it until it has had opportunity to produce results. Experience has proven that people know a good thing when they have seen it and in every city where this plan has had a chance to show what it can do the citizens have defended against all attacks thereafter.

Here is where the obligation rests upon you men to inform yourselves and to exercise that leadership so much needed by those who will not realize the truth of what I have told you until they see it in action.

There is plenty of opportunity for an experienced city manager to show results. Knoxville, Tenn., with a population of 77,800, adopted the city man-

ager plan in October, 1923, to take effect Jan. 1, 1924. Before going out of office the old regime made up a budget for the first year under the manager, which was $500,000 less than what they had spent during their last year. When the manager took office there was only $38,000 in the treasury, with the city owing practically every firm in Knoxville, while the local banks were refusing to advance another cent.

Government Improves

In spite of the reduced budget, the new government functioned better than the old one, and by the end of July of that year, a surplus had accumulated which enabled a tax refund to the citizens amounting to $280,000. Do you wonder that the citizens of Knoxville are successfully defending that kind of government?

Did you notice in the telegram from Cincinnati, these significant words: "Economies in major improvements astounding"? Let me give you one example of what Bill Light, president of the Cincinnati Rotary Club, is talking amout. Cincinnati chose C. O. Sherrill, the man who had charge of the government buildings and grounds in Washington, as their manager.

In the fall of 1924, the old government let a contract for the improvement of Kellog avenue. A little work was done on the contract in the fall of 1924. Sherrill took charge Jan. 1, 1925. He had the job re-estimated by his engineers and recommended to his commissioners that the contract be annulled. It was done. A little later he relet the same job, on improved plans and specifications, at a saving of seven hundred thousand dollars to the taxpayers. There is abundant evidence in Cincinnati today that the citizens generally will support government which is operated in their interest.

Up to Citizens

The movement to inaugurate city manager government in Indianapolis is distinctly one of the citizens. In it are men and women from all vocations, of all faiths and races. It is not the pet plan of any organization or clique. It is sponsored by a committee of seventeen hundred responsible citizens, of which committee any citizen is welcome to become a member at any time. We must have an organization powerful enough to win the referendum election, and cohesive enough to elect seven commissioners whose interest in the city transcends their interest in any political party. When such a commission has selected a competent manager, the merits of the new plan will soon be so well known to the citizens, that they will enthusiastically support it, just as they are doing in hundreds of other cities.

I am informed that the other side of this issue is to be presented before this club soon. I hope the man who is to make that presentation is here today. I want to inform him that the citizens of Indiaanpolis are going to judge the merits of these two forms of government on the basis of results, absolutely.

We have been told recently that the Federal system was designed by George Washington and the men of his time, and that it must, therefore, be good. If he were here today and were to drive over the street in this city that bears his name, George Washington woud sue us for libel.

Modern Men in Favor

George Washington never saw a concrete bridge, an electric light plant, a modern water system, a sewage disposal plant, an asphalt street, a street railway or a sewer system, but the great statesmen of our own day, men like Bryce, Roosevelt and Wilson, have said that the manager plan is the way out for American cities.

If the members of the Rotary Club feel that they are not sufficiently well informed on the operation of the Federal system, there is a widowed mother and two fatherless children living in my neighborhood, recently from Canton, Ohio, who can tell you something about the operation of the political system of city government. Political wiseacres are busy telling about all the dire things that may happen if we make the change, but, thank God, they can point to no city manager government whereunder the police and the gangsters have conspired to take the life of an upright citizen.

If your experience in Indianapolis has not already convinced you of the utter futility of trying to manage a city on a political basis, the citizens of Philadelphia can give you some valuable information. They had to call upon the President of the United States to lend them Gen. Butler to clean up the police department and now they are getting ready to pay up the millions the city officials squandered on the sesquicentennial exposition.

Cites New York, Chicago

The man who comes before you to defend the Federal plan will defend the system under which Tammany Hall runs New York city; the system which is misgoverning Chicago, with its gunmen and machine gun bootleg wars.

We have heard each political party refer to the administration of the other as "a stench in our nostrils." The olfactory nerves of the average citizen not schooled in politics, are not sufficiently sensitive to distinguish between a Republican or a Democratic stench, but the people know from experience that the results in this city under both parties have been equally disappointing.

Perhaps the gentleman who answers me will tell you that our school board is a fair sample of commission-manager government. It is nothing of the kind; never was, and was never intended to be. It is commissioner government pure and simple. The members of the school commission pass on every department head, every employe and every teacher. Under the city manager law of Indiana it is a crime for any member of the commission to solicit or suggest to the manager the employment of any person.

The only way to get the schools out of politics is to throw politics out of Indianapolis.

Asks About Past

I want the man who replies to me to answer this question. If the political system is able and willing to give us good government, why has it not done it during the last two years? If ever in the history of this city there was a time when those interested in politics owed it to themselves to deal fairly and squarely with the people, it has been the two years which have just passed. This administration took office knowing this movement was impending. They asked us to wait until they could show that good government was possible under the present charter. If with its very life depending upon it, the political system gives us what we are now getting, there is no use talking to the people of Indianapolis about expecting anything better from it.

Our city is the one thing we all have in common, we charge her with the responsibility of protecting our health, of educating our children, of protecting our homes and of preserving our lives.

If we were threatened with invasion from without, how quickly we would forget our differences and serve together for the common welfare. Every dictate of conscience and of common sense is that there is where we must begin, if Indianapolis is to be and become the city she ought to be.

ARGUMENT OPPOSING COMMISSION-MANAGER GOVERNMENT FOR INDIANAPOLIS

By Charles W. Jewett, Attorney, Formerly Mayor of Indianapolis.

(Address before Indianapolis Rotary Club.)

In an attempt to paraphrase the famous introductory paragraph of Daniel Webster's reply to Hayne, Abraham Lincoln once said: "When you know where you are, and know where you want to go, the next thing is to find out how to get there." So it may be well "for us to see how far the elements have driven us from our true course" in the storm of debate that has arisen over our municipal government. According to late bulletins from the city hall, we all realize where we are. We are agreed on where we want to go, but we have some honest difference of opinion as to how we may get there.

I have no more doubt that the "strong-mayor" type of the Federal plan is the best form of government for the city of Indianapolis than I have that the constitution of the United States is the best basic law upon which is established the soundest form of government ever instituted among men.

Enumerates Reasons

I am opposed to the city manager plan for the following reasons: It is a radical departure from the American conception of free government; it establishes an autocratic dictatorship depriving the people of the right to choose their chief executive; the law under which the manager plan would operate, is insufficient, inaccurate, indefinite and uncertain as a basis or constitution upon which to establish a new form of government; the power conferred upon the seven commissioners is absolute, unbounded and wholly without checks or restraints; the manager plan is an experiment and not a seasoned well established form of government for large versy, even though prominent citizens greater efficiency than can be secured under the present charter.

I have no apology to make for stating

my position in this important controversy, eve nthough prominent citizens have publicly stated that "the politicians are against the manager plan and all favor the present plan of government."

If intense interest in the kind of leadership and policies followed by my party; if active participation in the solution of public problems; if sincere efforts in each primary election to arouse the people to a realization of impending danger and appeal to them to wake them up and act before the damage is done; if four years of service as your mayor, with a cabinet of capable, unselfish, public-spirited men of outstanding character and integrity in this community, brands me as a politician, then I am proud to stand before you as such.

Question of Politics

Politics is the science of government. The question before us is one of government, therefore, it is a question of politics. No government, whether it be national or local, Federal or city manager, has ever been or ever will be taken "out of the field of political controversy." The "management of a city" is in the field of politics because it is in the field of government. So long as we continue to elect men to public office by the votes of people, whether the plan of government be the Federal plan or the city manager plan, city government will not be liberated from "the field of political controversy"

Any argument, such as Mr. Esterline made, has a strong appeal to those who have given but passing consideration to the subject. His argument is based upon the assumption that our charter is weak; that the governmental structure based upon it is a network of imperfections and that administrations operating under it are notorious failures, wasteful, inefficient and mostly corrupt. On the other hand, with the new-born zeal of a political reformer, he holds out to us a theory which he has idealized far above our power to conceive, as a system of practical conservative government to be administered by practical human beings. He contrasts with our present plan the system employed by our great industrial corporations established under a strong model law and put into operation by a commission of seven ideal, upstanding supermen. The question is upon the substitution of the industrial corporation plan of business management for our present charter of municipal government. First, let us consider what we propose to cast aside and abandon as ineffectual and worthless.

Charter One of Best

A few years ago when our charter was adopted it was considered a model for city government. Its adoption was a long stride forward. It is the product of the soundest and wisest thought emerging from the reform wave that swept the country at that time. It is the result of profound thinking; the application of sound basic principles, essential to the American conception of government. It conforms in theory and practice to our national standard.

City government is of two main types. The first is commonly known as the Federal plan or the mayor and common Council type. This form provides for three distinct branches of government—executive, legislative and judicial. The mayor or executive and the common Council or legislative are elected directly by the people. The variance of the relations between the authority of the mayor and the Council divides this type of government into two kinds, the "weak mayor" plan and the "strong mayor" plan. The mayor in the first plan is subordinate to the Council, while in the "strong mayor" plan the mayor has unrestricted executive authority.

In the second or "councilmanic" type, all legal authority is vested in the Council which is more commonly referred to as the commission. This type likewise is divided into two distinct plans. The one known as the "commission plan" which directly administers the departments of government, the other the "manager plan" which exerts its authority through an executive or manager selected by and responsible to the commission.

According to the last census there are 1,467 cities in the United States with populations of over five thousand. Of this number approximately 300 have the commission plan, and approximately 200 have the city manager plan, while 900 are governed under the Federal plan. There are 20 cities having a population of over 300,000. Of this number three only have the commission plan and three have the city manager plan. Of the fourteen remaining cities of over 300,000 population there are five only which have the "strong-mayor" plan. These are New York, Boston, Mass.; Detroit, Mich.; St. Louis, Mo., and Indianapolis. The prevailing form of city government

is the weak-mayor type in which the mayor is subordinated to the Council. With but two exceptions, Cleveland and Cincinnati, Ohio, the commission and city manager plans, where adopted, have succeeded this "weak-mayor" type of the Federal plan, and with the exception of Cleveland and Cincinnati, the "strong-mayor" plan has never been replaced. In both of these cities the most ardent advocates admit that the manager plan is still in the experimental stage and that even with a sweeping revival of civic spirit the promised theoretical results are far from assured, practical realities. The popularity of the commission and manager plans has been gained from the weak and irresponsible form of administration in which the Council has subordinated the executive and administered the departments of government in a discordant, decentralized fashion. The "weak mayor" plan has resulted in mismanagement without fixed responsibility. In cities and towns having this type of loose, irresponsible government, the pendulum has swung to the opposite extreme in the adoption of commission and manager plans.

Under our charter we elect one executive, the mayor, nine legislators or councilmen and a city clerk. The judges are appointed by the Governor. These officials are elected directly by the people and are accountable directly to the people.

Mayor Unrestricted

The mayor has unrestricted authority to appoint or remove all executive officers of his administration without the consent or approval of any other branch of the government. The mayor has sufficient power to be a real city manager. However, he knows no master, save only the people whom he directly represents. A city manager could not have greater latitude and authority. On the other hand, under the proposed plan, the manager is selected by the commissioners and is accountable to them only. He has seven employers to serve and a majority and a minority faction of his employers to satisfy. The commission has full authority to discharge him at will. If he is human and likes his $25,000-a-year job he will strive to please his many bosses, even if it becomes necessary to substitute for the sacred motto, "business efficiency," the more practical job-saver "business expediency."

The mayor appoints a city controller who is the head of the department of finance and is vice-mayor of the city. The controller receives all revenues and upon requisition pays all bills. He is the chief accounting officer of the administration. The mayor appoints the board of public safety consisting of three members, only two of which can be of the same political party. He appoints the board of public health, board of public works, board of park commissioners, board of sanitary commissioners, board of city planning and zoning, city purchasing department and all other administrative agencies of the government. The personnel of each of these executive branches of service must be appointed under either plan. Is it fair to assume that a manager who is accountable to several commissioners for his acts would be as independent in his selections as an efficient mayor accountable only to the people? Is it reasonable to believe that seven men with equal powers, elected by the people can discharge executive duties more effectively than one executive elected by the people. A brief survey of the authority and responsibility of the mayor under our system proves conclusively that it is not a weakness in our charter or constitution of government that prevents us having strong men to administer it, but rather the weakness is in ourselves as voters that we do not select men capable of using the authority vested in them. Is it reasonable to assume that we will be more intelligent and careful in selecting seven men than we have been in selecting one?

Council Checks Executive

The common Council has legislative power to enact city laws. As in the national Congress and the state Legislature, this legislative branch of the government has certain administrative functions to perform, which are designed to be "checks" upon the executive. The Council holds public hearings on the budget, at which citizens are urged to appear for the purpose of hearing read the program of work proposed by each department for the coming year, to learn the estimated cost of the same and the proposed rate of taxation necessary to produce revenue sufficient to complete the work program, and the public is invited to enter into the discussion of the various items either of revenue, expense or work, as set out in the budget. Criticism and advice of interested taxpayers is earnestly sought and even advertised for, but sad to say, very few ever answer the advertisement.

The tax rate is fixed by the Council, usually in accordance with the recommendations of the mayor and controller. All appropriations of revenue necessary to carry out budget requirements must be made by the Council. It must approve all contracts entered into by the administration calling for expenditures of $2,000,000 and more. There are other minor administrative functions of the Council.

It is true that the legislative branch can hinder the executive by withholding appropriations, providing insufficient revenues and refusing to approve contracts. In like manner the state Legislature may restrict the Governor and Congress may hinder the President. The last Congress very seriously handicapped the national administration by failing to pass certain appropriation measures providing necessary revenues, but do we hear the advocates of "industrial business efficiency" starting a campaign to abolish Congress, dismiss the Supreme court sine die and do away with the office of President of the United States and set up instead a board of commissioners with instructions to cable Mussolini to come over at once and give us his best brand of "industrial business efficiency?" That sounds ridiculous, but it is exactly what some of the leading citizens of this community are proposing to do with the best form of city government that any city in this country has today.

Remedy for Abuse

The abuse of the power which the Council has to check and balance the power of the executive by using it as a club with which to exact concessions, may readily be checked by charter amendment. At present we have six councilmanic districts covering the southeast, southwest, northeast, northwest and two central sections of the city. One candidate from each political party must be nominated from each district. After nomination the six candidates of each party run at large. The six candidates of the majority party and the three of the minority party receiving the largest number of votes at the November election constitute the Council. This gives that body a membership of nine, six of whom come from the six districts respectively and are of the majority party, while the other three of the opposite party and are elected irrespective of districts. Six members may form a working combination that can control all legislation and administrative functions, as well as pass measures over the veto of the mayor. A combination of five is sufficient for all purposes, except to override a veto. Almost without exception there have been combinations within the council formed for the purposes of reciprosity with the executive. Party lines mean nothing in the life of the average councilman and frequently members of the majority party have joined with one or more members of the minority party to effect such a blockade to administrative programs. Some mayors concede to the demands and the program moves on, others "grin and bear it." It is not necessary to throw our entire system into the discard and substitute in its place a plan that is equally susceptible to rapidly changing majorities which new alignments would result in equally rapid changes in both personnel and business policy. An amendment to the charter would make improbable such a tie up. Each party should nominate, as at present, one candidate from each district and in addition five candidates at large. After nomination all eleven candidates should be voted on by the entire electorate and the eleven candidates irrespective of party receiving the largest number of votes, elected. This would give an opportunity to secure five men as candidates at large. It would give the mayor eleven men of his own party which would insure a working majority for such necessary action to promote honest and efficient co-operation, while it would insure the public against the unwise, imprudent or dishonest acts of the executive.

Checks Are Needed

If there is any unit of government from the national to the township which should have "checks and balances" it is municipal government. The check which the Council has on the executive if exercised by honest, intelligent men, will never hinder progress but will always be a safety valve of protection again dishonesty and wastefulness. Mr. Esterline says this legislative safeguard "has made our municipal motor car all brakes and no motive power." He says "we have set the brakes and taken out the spark plugs to keep the boys from running on the rocks. It is safe perhaps but it gets no place." His proposed manager plan has no checks or safety devices whatsoever. Seven commissioners are elected without respect to localities. This commission serves for four years. The

people can not recall them for misconduct. They become the supreme autocrats of all municipal affairs. The commission makes the laws, it executes the laws and it appoints its judges to interpret them. It is the unrestricted, unrecallable, all-powerful dictator of our government. It is the last word in high-powered motors, with hot sparks in every cylinder, geared for extreme speed, no windshield, no brakes whatsoever, to be driven over the slippery, winding hills of political vicissitudes by inexperienced political theorists, eager to step on the accelerator and give it the gas. This governmental device is much too powerful and dangerous to be entrusted even in the hands of the most dependable administrators. Even Mr. Esterline would not sell us the idea that his high-powered, efficient governmental motor is a new design, made in America, when all who have looked under the hood recognize it as an old obsolete model which since the war has lost cast even among the autocrats of Europe. Mussolini, however, has repossessed the old car that Julius Caesar drove through the streets of Rome, and clad in the black shirt of his order, is establishing new speed records with the old motor for concentrated power and business efficiency.

Limitations of time prevents a more thorough analysis of the details of our present system. However, from even this brief sketch of the powers and functions of the two principal branches of the government it must be apparent that it is not necessary to abolish the good we have, but only strengthen it and then elect a good city manager as mayor of Indianapolis.

Argument Falacious

The most deceptive argument advanced in favor of the manager plan, and likewise the most falacious, is the comparison of city government with private corporation management. Quoting the language of Mr. Esterline, the argument is: "What could be more logical and more sensible than to replace a scheme which has failed in our municipalities with the plan which has been so successful in our private corporations," and further quoting, "I want next to show you the type of organization used by practically all private corporations. The first in authority are the stockholders, who elect the board of directors who fix the policies and select the administrative officer. The general manager selects his department heads, and they, the employes of their respective departments. This," says Mr. Esterline, "represents the best that business experience and ingenuity has been able to devise." In summing up, he says: "Now compare this with the chart of the city manager plan of municipal administration. The citizens who are the stockholders, elect on a nonpartisan ballot a board of commissioners. These commissioners govern the city, they fix the policies and select, employ, supervise and control with right to remove a city manager . . . who appoints, supervises and controls all department heads, who in turn control all the employes of their respective departments." This diagnosis and prescription by Dr. Esterline sounds like the last word had been spoken and the patient has a chance to recover. However, his major premise is wrong because the city is not a private corporation and can not be operated under the same kind of corporate charter and by-laws.

In government there are two elements —those who govern and those who are governed. The right to govern is derived by the consent of those governed, as we understand it in this country. There are two extreme forms of government—the autocratic, which results in tyranny, oppression, coercion, submission and reaction, on the one extreme and the pure democracy, which results in demogogism, license, impulse, agitation, discontent, anarchy and chaos, on the other. The "mean" between the two is exemplified in our own republic—a representative government resulting in liberty, reason justice, contentment and progress. All people, who have government, must submit to or consent to be governed under one of these three general forms.

Two Elements in Corporation

The corporation likewise has two elements in its government—those who govern and those who are governed. The stockholders, directors and executive officers are the governing class. The laborers are the governed class. They are governed without representation unless they are also stock owners in the corporation and even then their vote is limited by the number of shares they own. In industrial government the voice of the individual stockholder is commensurate only with the amount of stock he owns. Often a single individual owns control. Efficient, perhaps, but autocratic. In free government the voice of

the individual is neither greater nor less than that of every other citizen. Wealth nor poverty, neither amplify nor stifle that voice. Inefficient, perhaps, but democratic. To make the analogy complete between a private corporation and a government, we must either permit the laborers in the corporation to have equal voice in the affairs of the corporation on the one hand, or we must make government identical with business organization by limiting the voice of the individual to the amount of property he owns. In other words, if a citizen isn't a property owner he can not be a stockholder in the government and, therefore, not entitled to vote. The analogy is falacious and absurd. The modern successful corporation is closely controlled and managed by a dictator. It is autocratic in its government. In the selection of its directors; in the fixing of its policies; in the continuity of management it does not rely on the votes of the thousands of its employes. In the municipal corporation the sovereignty of the commonest citizen can not be sacrificed even for the most efficiency so long as we continue to have free government.

The basic principles involved in changing our form of government to the form of the efficient industrial corporation may be more far reaching in their consequences than at present realized.

Not U. S. Style

The comparison of our government with the organization and management of corporate industry is as falacious, deceptive and misleading as a comparison of the governmental structure of imperialistic Italy of today and that of our own republic. This government is not founded, nor was it meant to be, upon the principles of business organization employed by the great railroad companies, the steel corporations and other gigantic industrial corporations. We live here in America, where the sovereignty rests in the citizenship and the majority may rule if it is willing to assert its inalienable rights and no set of bosses or political overlords can prevent it.

Mr. Esterline said, "For a good many years it was my business as an engineer, to examine the internal organization of many industrial corporations which were suffering from bad management. One of the most damning things we found in such organizations was internal politics resulting from indefinite fixing of authority and responsibility." Did Mr. Esterline immediately and without hesitation recommend that the company completely abandon its corporate charter and become a partnership rather than retain the basic charter and eliminate politics from management? There is just as much reason for so doing, in the case of a mismanaged business corporation as there is in the case of a mismanaged municipality.

It is argued that the present system lacks continuity of service and business policy necessary to progressive government, because the elective officers are changed each four years. This is a valid criticism with which I agree, in so far as the limitation upon the tenure of offic of the mayor and Council is concerned. It is admitted that private instructions would be less successful in operation if it were compulsory that the chief executive officer be changed each four years! However, it is not necessary to abandon our entire charter to insure continuity of municipal policy. We should amend the charter to permit the re-election of city officials. An efficient administration deserves a vote of confidence by re-election. An inefficient administration could never perpetuate itself if an aroused citizenship asserted its power at the polls. Of the five "strong-mayor" type cities Indianapolis is the only one to limit its officials to a single term. Even under our present plan we are assured of continuity of policy for at least four years while statistics show that the average term of city managers up to March 1, 1925, was less than two and one-half years. Under our charter definite provision is made for continuous service and policy by a majority of the boards. The terms of office of members of the finance department, purchasing department, department of law, board of public works and board of public safety are concurrent with the term of mayor, while the terms of office of members of the department of health and charities, department of park commissioners, the sanitary board, the city planning and zoning board and the board of sinking fund commissioners, together with other minor boards, do not expire at the same time, but only one term on each board expires each year, leaving a majority of old board members on each board at all times. These safeguards are provided in our charter and are a part of the spirit of the fundamental law of the city.

Prior to the last two administrations the incoming mayor has adhered to this charter provision. Public opinion in this city should be such that no mayor would dare violate the spirit of the charter in this respect. The continuing boards of city government are designed as nonpartisan and the people should demand and see to it that they are maintained on that basis.

Charter Ignored

However, you may be surprised to know that, notwithstanding the fact that charter provisions have been ignored and these boards changed at will, for no apparent good reason, that over 40 per cent of the major employes of the executive departments have served continuously more than eight years. The chief executive officer of the board of health, Dr. Herman Morgan, has been in service over fourteen years, while eight of his subordinate officers have served ten years or more. In the department of parks, ten major employes have served more than eight years, one has served twenty-eight years, one sixteen years, two twelve years and one ten years. In the assessment bureau, six have served more than eight years. The city civil engineer. Frank Lingenfelter, has served twenty years in the department either as the head of the department or as engineer in charge of track elevation. Under the board of works, sixty-three major employes have served two or more administrations. One has served thirty years and another twenty-eight years. Barney Controy has been the faithful superintendent of sewers for forty years. The chief chemist of the city is now serving his fifth administration. Fifty per cent of the major employes under the board of works have served at least three administrations. A complete survey would disclose other interesting facts relating to continuing service under our present plan.

On the other hand, statistics taken from the sixth yearbook of the City Manager Association and the City Manager magazine, Vol. 7, No. 3 (March, 1925), disclose the startling and unanswerable fact that less than three hundred cities having the manager plan have employed 681 managers. Thirty-four of these had served more than a single city at the same time. The thirty-four managers held an aggregate of eighty-five positions. Of the 278 managers holding single positions, thirty-six served less than one year; seventy-four served one to two years; fifty-five from two to three years; forty-two from three to four years; twenty-four from four to five years; twenty-one from five to six years; fifteen from six to seven years; six from seven to eight years; four from eight to nine years, and one served eleven years. It is impressive to note that of the 278 managers, only twenty-six served as much as four years, or the term of our city mayor. From these authentic figures taken from the records compiled by the "profession" of managers showing that in all of the manager cities the average tenure of service is but little over one-half the term of our executive, it appears that instead of insuring long, uninterrupted, continuous adherence to a fixed policy, the manager form is an ever-changing short-term plan, even in cities having a strong, comprehensive law as a basis and assurance of continuity. The manager laws governing Cleveland, Cincinnati and Dayton, Ohio, and Kansas City, Mo., make elaborate and thorough provisions establishing the merit system, governing the appointment and removal of city employes. Such a law, resembling our Post Office Department, does indeed secure permanence of tenure and prevents the use of appointments as personal or political patronage. Examination of the Indiana law shows that it entirely omits all provisions for a merit system of appointment and discharge. The Indiana law omits the very provisions which are found in Cleveland, Cincinnati, Dayton and Kansas City to insure permanence of employment by city employes.

Political War Inevitable.

Much criticism has been directed at our charter because it provides for election of city officials by political parties. The argument is made that the activity of national parties has no place in the issues of city government. Granting that to be true, nevertheless, so long as we elect men to public office, we will have political parties, whether they be national or local. Men will organize to carry out their desires. A nonpartisan ticket would destroy the national party alignments in city elections, I have no doubt. But in local affairs among the thinking classes, national party lines are almost obliterated under the present system. The stronger we tighten party lines, the more party responsibility we will have, which will be followed by better and more responsible government.

When party lines fade out class lines appear. Where party loyalty and responsibility disappear, blocs and class radicalism loom up. Abolish the arraignment of party against party and you stimulate an arraignment of class against class. Striking and alarming examples of mass voting irrespective of party lines have been evident in recent years when the combined strength of the best elements of all parties was unable to stem the tide.

Voters will divide themselves on candidates and policies. Such division may be much safer on existing party lines than it would be on new ones.

Why should we change the form of our government? The advice of the city manager of Cleveland is not to do it. After one year's experience William R. Hopkins, city manager, when asked the question, "Ought other great cities adopt the manager plan?" answered: "I'm afraid not; it works all right in the smaller cities but I do not think, with only one year's experience, that any large city would be justified just now in following Cleveland's experiment." And then he said, "Just as long as you have men getting into the city council through political fights in their own districts, you will have men in the city council who have political debts to pay, and you can't have strict business management if there are political debts to be paid. If a city has a manager who needs his job and who depends for it upon the good will of the council, it will be likely with a council the size of Cleveland's to have the city bossed by a majority of the Council." These are the wise words of warning from the manager of the largest city to try the new plan. Mayor Townes of Cleveland, when asked, "Has politics been put out of business in city government by the new charter?" answered: "No, sir, and I don't see how politics in one form or another can be kept out of government of a big city." Ex-Mayor Frederick Kohler of Cleveland says, "The trouble with the city manager charter is that it changed everything but human nature. Folks elect the same kind of people and the same kind of people run for office whether you call them aldermen or councilmen, no matter what the charter says." Kohler said that it was costing citizens $2,000,000 more a year to run the city under the new plan.

These facts come from men who have conducted this governmental experiment in a large city under strong, well guarded law and put into operation by the very best type of manager. At the same time the government of Cleveland is no more constructed for efficiency than our own. No one seems to know just what our manager plan law really means. Can Mr. Esterline tell us whether the proposed commissioners under the law supersede the Indianapolis school board, the sanitary board and the park board? We now have a civil city, a school city, a sanitary city, and a park city for the purposes of taxation. Will all of these be merged into one, if the new plan is adopted? This is of vital importance as affecting the constitutional debt limitation of the city and should be made definitely clear by the proponents of the new plan.

Hard to Select.

It is argued that the voters can not under our present system, intelligently select public officials because they have no reliable means of appraising the fitness of candidates. It is urged that a commission of seven men is more competent to select a manager than the people are to select a mayor. But what about the selection of the seven commissioners who are to do the selecting for the people? By what process of reasoning do the proponents of the manager plan conclude that the voters can intelligently know the fitness of seven executives to be elected when they maintain that it is impossible for them to know the fitness of one executive? In recent elections the voters have elected a board of school commissioners who in turn appointed a business manager for the school city. These officials are now in office and have full charge of the school city. They levy taxes, expend vast sums of money, employ hundreds of teachers, select a school superintendent and scores of school principals and direct the educational policy of our public schools. They were elected by direct vote of the people after a spirited campaign. I venture the assertion that there are not twenty men in this representative gathering who can name the members of the majority faction of the board, to say nothing of naming all of the members, and it is possible that there may be some one here who can not name the business manager of that important board. We have in the courthouse a board of county commissioners charged with the responsibility of levying taxes for the county and expending large sums

of money for county governmental requirements. They were elected by the people. Can we name them? Did we know their qualifications for the important office they hold when we voted them into power? If not, why not? If we do not know the school commissioners, what convinces us that we would know the city commissioner? I think I may say, without fear of successful contradiction, that everybody present can name the last two mayors of Indianapolis. Most of us probably can name all of the mayors who have served under the present city charter. The fact that more of us do not know our candidates and public officials is not the fault of our system, but may be attributed to general apathy on our part. If we can not know our public servants under a democratic form of government, why should it be contended that we would know more of their qualifications under an autocratic system.

Practical Problem

The problem of municipal government is a practical and not a theoretical one. It is not safe, it is not fair, to compare all the practical weaknesses of our present form with only the theoretical strength of the city manager plan. We know that there is always a vast difference between theory and practice. Our present system theoretically is far more American than the proposed system which is modeled after old-world forms of efficiency, councils, dictators and benevolent despots. The fundamentals of American government from the smallest unit to the Federal capital have been wrought out through a mighty conflict of tongue and pen and gun and sword, and have come down to us a heritage of untold value if prudently managed, if carefully watched, if vigilantly guarded, but a heritage easily wasted, easily lost, when we forget that "vigilance is the price of liberty."

Too many of us want that heritage to pay dividends in happiness, peace, protection and prosperity, but are not willing to put forth the effort necessary to guaranty these benefits.

Some want to trade the old homestead for a factory in town. Let us revise our sense of value before we make the trade. Our present system is more sensible than the proposed plan. The success of either is predicated on the human element. Men must run the city under either plan. Public opinion must be formulated and expressed under either plan. Public servants must heed the voice of public opinion under either system. But under either system if there is no voice of public opinion, or if part of you are sending up a calamity howl to the world and doing nothing to make our public servant hear us then sometimes we find him listening to his master's voice emanating from the business end of the machine.

What we need most in this city is less talk and more action, less criticism and more cooperation; less blues and more sunshine; more politicians and fewer tired and retired business men. We need more students of municipal government and fewer industrial efficiency experts. We need a new baptism of civic pride, the kind that we not only talk about but work at. We can not have piano player government where we drop a coin in a slot and get just what we want. No system of government runs automatically.

No Time for Change.

The most casual student of the text of our municipal charter will readily learn that under its provisions, if adhered to by public officials, it is possible to have a splendid administration of public service. The people elect the chief executive, giving him full and absolute power to make his administration and to put into effect his governmental policies. Having given him this broad grant of power they hold him responsible for results. Our present system has been tried. Its powers and limitations have been established by the courts. It is not an experiment. Why should we change the form of our government for a system that at best in the larger cities is purely an experiment? Any change that the people might vote in the June election would not affect existing conditions, and no positive results could be obtained until after the next municipal election. Why give up a tried system under a well established law for an experiment under a weak and uncertain statute?

"If the people of Indianapolis really desire a city manager government is the change not of sufficient importance to provide first a comprehensive law, safeguarding the people's rights before we proceed to revolutionize our system of government? This is no time to arouse an impatient restless citizenship. The public mind is not sufficiently calm at

this time to change the constitution of our government . Those who have not the opportunity to study the basic principles involved in the radical proposed change may easily be led to believe that anything is better than what we now have. In fairness to the voters and in the best interests of the future welfare of our government we should realize that this campaign is not directed against the administration of our charter but is directed against the charter itself. If the men and women who are advocating this fundamental change, will manifest the same degree of activity and give the same time, thought and energy in the selection of candidates for office in the next municipal campaign, there will be no need for a municipal revolution of our governmental system.

Let us not forget the old classroom motto, familiar to all of us:

"Be not the first by whom the new is tried,
Nor yet the last to cast the old aside."

WHAT ABOUT TOLL BRIDGES?

By O. L. Hemphill, State Highway Engineer of Arkansas, Little Rock.

(From "Arkansas Highways" for December, 1926.)

Because of the large mileage of rivers in the state, the people of Arkansas should be very much interested in the toll bridge question, a question of importance to any state which has a considerable mileage of large rivers without bridges at all highway crossings.

Until a bridge is provided where a highway crosses one of these streams traffic must cross the stream by means of a ferry, a method always more or less unsatisfactory, always dangerous to a certain degree, and a method which always must be considered as a temporary means of handling traffic. A ferry, because of its more or less undesirable features, present to some degree at every ferry, is considered with disfavor by the traveling public. This disfavor is growing all the time, and has reached the point where public opinion demands that bridges replace ferries wherever there is any considerable volume of traffic. The traveling public, of course, always favors a free bridge over a toll bridge, but with a realization that it is not always possible to construct free bridges, this same public is willing, and generally urges, that toll bridges be constructed in those cases where free bridges are not possible.

It should not be understood that this article attempts to say that the public in general favors toll bridges, but there is no use denying the fact that public opinion prefers a toll bridge to a ferry. What public opinion wants it usually gets provided the opinion is strong enough, so we might as well admit that we are faced with the alternative of providing free bridges, or of having toll bridges constructed where the traffic is heavy enough to insure an adequate return on the investment.

The statements in the preceding paragraph are general in their nature. Let us now consider specific conditions in the State of Arkansas, and see how we are situated regarding bridges. Twelve million dollars is a conservative estimate of the amount necessary to construct adequate highway bridges at those places where navigable streams are crossed by the roads of the State Highway System, and where no bridges now exist. This estimate does not include anything for the construction of bridges over the Mississippi river.

The construction of a bridge means the expenditure of a large amount of money on a short section of highway. This statement means more with an illustration of comparative costs. Many of the bridges required in Arkansas would cost $350,000 or more. This sum would build 10 miles of concrete road, or from 30 to 40 miles of gravel road. These figures include the cost of ordinary grading and small drainage structures. With the limited amount of state funds available, as compared to the large mileage of state roads needing improvement, it is plain that no very considerable amount of state funds can be used in the construction of bridges, where a large expenditure adds but little to the completed mileage of the state Highway System.

Conditions being as they are, we may be assured that toll bridges are going to be built at a number of places in Arkansas, unless funds for the construction of free bridges are provided by local improvement districts, and this will happen in only a few cases. Since we can be sure that there are going to be some toll bridges in Arkansas, in addition to those now in operation, we shoud be interested in the question of how these

toll bridges are to be built and operated. Will they become free bridges after their cost has been paid by the tools of those who use them, or will they continue to take a tax from every traveler who passes over them, 10, 15 or 20 years after they have paid for themselves?

There is much that might be said against the latter condition. It is a fact that such bridge, for private gain, places a toll barrier across a highway that has been paid for by the public; and that construction, by the state or county, of the roads leading to a toll bridge, really accrues to the benefit of the individual or corporation owning the toll bridge franchise, for the bridge would pay but small return without passable roads leading to it.

A remedy which has been suggested for this condition is a provision in the franchise for turning the bridge over to the state or county after it has earned enough in tolls to pay for itself and pay a certain return on the investment, but it is doubtful if many bridges will be built under such a plan. The individual or corporation that secures a franchise and constructs a toll bridge, hazards the investment against the probable returns from tolls. Under this kind of franchise there is no guarantee that six per cent will be earned on the investment, but there is a provision against earning more than that amount. There is little incentive, therefore, to hazard an investment in this kind of bridge, for while the investor chances a loss, the maximum return is but little more than can be secured from absolutely safe investments.

Several of the states of the Union are vitally interested in the toll brige question, and the fact that many states have no large streams is the only reason why this question is not more of a national one than it is. With the steady increase in long distance automobile travel, however, so that more and more people drive over the roads of other states, hundreds of miles away from their own locality, this question is forcing itself on the attention of a large percentage of the national population, and the people of many states, heretofore not interested in the question, are now voicing their sentiments in tones loud enough to be heard everywhere.

A great many thinking people now are advocating the opinion that all highway bridges should be built by the state or by political subdivisions of the state. Realizing the fact that the money is not available for constructing all the necessary bridges as free bridges, and that some toll bridges must be built, they are advocating that the state or its political subdivisions should build and operate such toll bridges as are necessary, collecting tolls for only such a length of time as will allow the bridges to be paid for with the tolls collected.

A bill was introduced at the last session of the Arkansas legislature, authorizing the State Highway Department to build bridges over the larger streams of the state, financing the cost of construction by bond issues and retiring these bonds with tolls collected, but this bill did not become a law. The same legislature, however, did pass a bill providing for the construction of a toll bridge over Red river, at Fulton, to be constructed and operated by the State Highway Department under the same plan proposed by the proposed general act. This bridge will become a free bridge after the bonds are retired. The county judges of Miller and Hempstead counties issued a franchise to a corporation granting authority to construct and operate a toll bridge at this place, and this corporation, claiming that the authority of the county judges in this matter is superior to the authority of the legislature, has taken court action to prevent the construction of this bridge by the Highway Department.

Before a bridge can be built over a navigable stream that extends into two states, a bill authorizing its construction must be passed by the Congress of the United States. Most acts of Congress giving authority for corporations to construct and operate toll bridges, also confer the same right of eminent domain that is exercised by other public utilities, consequently, in those states where state authorization is not required, an act of Congress can allow a toll barrier, in the form of a toll bridge, to block a state highway without the assent of any state agency. Sometimes, in fact, this action is against the desire and wishes of the state, and this, of course, brings on a discussion as to the invasion of the rights of the state.

In Arkansas, by reason of constitutional authority given to county judges, a franchise for a toll bridge must be secured from the county judge of the county in which the bridge is to be lo-

cated. In the event that the bridge spans a river forming a boundary between two counties, the franchise must be issued by the county judges of both counties. Here we have the fact that a county, by reason of the action of its county judge, may allow the placing of a toll bridge across a road of state-wide importance, perhaps of national importance; a bridge which will require every traveler on this important road to pay a tax for a period which may vary from 25 to 50 years. The road on which the toll bridge is to be located may have been improved for many miles on either side of the bridge with funds provided by the entire state, or, in some cases, with funds provided by the entire nation as Federal aid. Because of the demand of the public, however, for bridges of some kind, this condition will not only continue to exist, but will become more common, until some provisions are made whereby toll bridges can be built and made free bridges as soon as paid for by tolls collected.

A recent decision of the Comptroller General of the United States, relative to the provisions of the Federal Aid Highway Act regarding payment of Federal aid on roads leading to toll bridges or ferries further complicates the toll bridge question so far as Federal aid is concerned. According to this decision, Federal aid cannot be used on a road which exclusively serves any kind of toll service, whether this toll service be a ferry, a bridge owned and operated by an individual or corporation, or a bridge owned and operated by the state or a political subdivision of the state. In other words, on a road leading up to any kind of toll service, no Federal aid can be used beyond the point at which some road leads off, by which a detour of the toll service can be made. It makes no difference if the toll bridge is operated by the state or a political subdivision, with the expressed intention of making it a free bridge when paid for by the tolls collected. According to a Comptroller General's decision it is a toll service and Federal aid can not be used on a road which serves it exclusively.

Toll bridges will be built in Arkansas, and this cannot be denied. The question which should be considered seriously by every citizen of the state is: How and under what conditions are these toll bridges to be constructed and operated?

THE PROFITLESS HIGHWAY BID

By Leslie R. Ames, State Highway Engineer, Raleigh, N. C.

(From an address before annual meeting of Associated General Contractors.)

The obligations of the state highway commission may be briefly outlined as follows:

1. The adoption of a definitely laid-out system of state highways.

2. Location of roads which are most necessary to the public weal.

3. Engineering study of each location taking into consideration the various factors entering into alternate locations.

4. An intensive study and survey of the availability and quantity of local materials.

5. Decision and estimate of the present traffic, intensity, kind and weight, and also as to the expectancy of future traffic ten to twenty years hence.

6. Drawing of proper specifications and plans, one agreeing and tying in closely with the other so that the final product, the completed road, will in itself, or by progressive steps, be adaptable to the traffic requirement.

7. Proper methods of advertising and presenting these plans and specifications to the contracting fraternity in such a way that the state highway commission will receive bids, properly secured by a reputable bonding company to protect the taxpayer.

8. The proper award and execution of the contract.

9. Finally, the proper administrative and engineering organization to carry out the various details in connection with the steps outlined above.

The State of North Carolina has been singularly fortunate in having as chairman of the State Highway Commission, Frank Page, a man who has saved the taxpayers thousands of dollars, and a man who will always open his door to you contractors and will send you out feeling that you have gotten absolute justice.

The state cannot force a contractor to bid on its work nor can the state force a contractor to bid without a profit. The advertisements and proposals are sent out to contractors informing them that there is to be a public letting on a certain date under well defined plans and

specifications, and it then rests with the contractors, as to whether or not they wish to bid and also as to the amount of their unit bids.

We have awarded contracts in this state in the amount of approximately $125,000,000, and there have been 41 actual defaults. This does not mean that 41 contractors have been defaulted, however. Considering the large program that has been carried on in the comparatively short period of six years, we feel that the percentage of defaults has been small.

Reasons for Defaults

We have gone further than this and have analyzed the reasons for these defaults. Only two of the contractors defaulted due to underbidding their job. The other failures were due primarily to lack of experience in the contracting business. They had practically no equipment, which means that they had no funds. Six of the failures were directly traceable to neglect of business. Back of all this stands the bonding company, for the reason that if they had conducted the proper investigation before writing the bid bond, the majority of these defaults would not have occurred.

In this particular state, we do our utmost to so word the specifications that the minds of the commission and the contractor may meet in mutual understanding. Unless the specifications are explicit and in detail, there will be various interpretations placed on them by the contracting parties. It is also our desire in this state to make the contractor feel that it is his right and privilege to appeal from the decision of any subordinate, provided he thinks he is being required to do work outside the specifications.

After issuing the ivitation for bids, the specifications, the plans, and the form of contract, it is up to the contractor to consider whether he will bid under said conditions. Should the state go further?

I assume—and it is on my part only an assumption, that the subject of this paper which was given me by one of your representatives, might be answered by saying—"Yes, the state should go further."

Determining Qualifications of Bidders

The bids have been received and checked, and after tabulation we find a certain contractor has submitted the lowest bid. The question then arises as to whether or not the low bidder is responsible.

The North Carolina State Highway Commission before awarding a contract requires the low bidder to fill out a standard experience questionnaire and financial statement, which questionnaire and statement is carefully investigated before the actual award is made.

In awarding the contract, we do not hesitate to throw out the lowest bidder, provided in our opinion he is not responsible and is incapable of carrying out his contract. The contractor in signing the contract has bound himself to complete the work according to the plans and specifications. If he has bid without a profit there are always complications encountered by the contractor continually harassing the state highway official with the idea of producing inferior work which does not meet with the specifications.

Five Parties Involved in Contract.

While there are only three parties actually signing the contract, there are in reality five parties involved, namely: the state highway commission; the contractor; the bonding company; the material man; and the taxpayer.

If the contractor has bid without a profit, and particularly if the contractor is an irresponsible one, the five parties involved in the contract are soon surrounded by difficulties, due to the fact that the contractor is unable from his profits to pay the material man, and he is continually attempting to construct the work in such a way that he does not try to carry out the specifications.

One of the greatest difficulties with which the state highway officials have to contend is the fact that the contractor before signing the contract is not entirely familiar with the specifications. I believe that a great deal of missionary work could be done by your association by drilling into its membership the fact that before bidding on work of any nature, it is absolutely necessary to study and to know the specifications in detail under which the work is to be carried out.

The state highway commission of our state revises its specifications yearly. Considerable time and expense could be saved, both by the contractor and the state highway commission, if the con-

tractor would familiarize himself with the various details of the specifications.

It is my understanding that one of the chief objects and aims of the Associated General Contractors of America is directed to the end that responsible contractors may be insured. It is needless to say that the North Carolina State Highway Commission has no definite solution of this problem. However, we stand ready at any time to confer with your association, and are also willing at all times to receive suggestions from you.

Your association can also be the means of eliminating the dishonest contractor. Investigations by your association along with cooperation from the State License Board is the most practical solution of this problem.

The various joint conferences and discussions in meetings similar to this should be helpful to contractors in obtaining worthwhile information regarding construction methods in all the various phases of the big building industry now being carried on. A conscientious study and analysis of the information given out, a willingness on the part of the contractor to cooperate with the engineer, a concerted effort by contractors to be honest in their operations to put forth 100 per cent effort and industry after the work has been started, will be helpful in assisting a contractor to build the ultimate roadway and at the same time make a satisfactory profit commensurate with the finished product.

INTERMITTENT SAND FILTERS FOR SEWAGE

By Ernest Boyce, Chief Sanitary Engineer, Kansas State Board of Health, Lawrence, Kans.

(Presented at Eighth Conference on Sewage Treatment at Ames, Iowa, November, 1926.)

The first use of intermittent sand filters in sewage treatment was for the whole process of treatment. The sewage was applied without preliminary treatment to remove suspended matter, and in the operation of these filters it was contemplated that the removal of the suspended solids from the surface of the sand would be a part of the routine operation.

The first sand beds used were natural sand deposits more or less completely underdrained. The filtering material being naturally in place, the removal of the surface of the sand filter with the removal of the deposits formed from the suspended solids was a matter of little concern. Practically the only cost was the cost of its removal when it became so badly clogged as to cause ponding.

Most of us are familiar with the sand filter as one of the several devices for the oxidizing of the liquid and non-settleable organic matter present in the effluent from the various types of settling tanks. When so used, surface clogging is still a problem that requires the regular raking of the surface and the periodic removal of the surface of the sand.

The other extreme in the use of the sand filter is to use it as a finishing process following sedimentation, sprinkling filter or contact bed, treatment and resettling in this use, it serves to remove the last remaining part of the unoxidized dissolved organic matter and more important perhaps at this stage of treatment, it serves to bacterially purify the effluent. With the increasing popularity of the sprinkling filter as a means of secondary treatment, there has been less emphasis given to the removal of bacteria as a desirable part of sewage treatment; most of the emphasis being placed on the removal or oxidation of oxygen consuming substances.

It is not at all improbable that in the future, at least on certain streams where the bacterial quality of the receiving stream must be protected, sand filters will be used along with chlorine as a finishing treatment following other processes intended primarily for oxidation.

Intermittent sand filters, while requiring considerable maintenance in order to prevent ponding, are capable of producing an effluent that is well oxidized and has a lower bacterial content than is obtained with the coarser grained biological filters.

Where small plants are to be constructed to discharge into dry waterways, the sand filter is less apt to fail through neglect than other secondary treatment processes in common use. If the sand bed is unbroken and ponding is prevented, there can hardly be a failure to oxidize the effluent to a nonputrescible state. The most common failure of a sand filter is the destruction of the biological aspect by ponding. This may be due to surface clogging or to a failure of the syphons to properly alternate,

giving a continuous discharge of settled sewage onto one bed.

Too frequently the sand bed is regarded by the operator merely as a filter. The importance of the careful draining of the bed between doses of sewage can not be too strongly stressed. Unless the bed drains so that air can carry the oxygen to the minute organisms living as films covering the sand grains, these organisms not only fail to have the oxygen necessary to combine with the organic content of the sewage and thus oxidize it as a part of their life process but being deprived of oxygen, they die and the filter bed becomes inert. Slight ponding is followed by reduced biological activity in the vicinity of the ponded area and unless corrected, the destruction of that section of the filter, insofar as oxidation is concerned, rapidly follows. The inert sand will tend to compact still more and the ponding increase until the filter must be taken out of service. It is not infrequent that a plant will be operating so near to capacity that the removal of one filter unit will seriously overload the others with a progressive failure of all the beds.

Sand filters are quite popular in Kansas and are to be found in 28 of the existing 93 sewage treatment plants, 62 of which have some form of secondary or oxidizing treatment. In all but two of the 28 plants the filters follow Imhoff tank treatment. In one instance the sand filter follows a septic tank and in the other, natural sand beds are available for the disposal of raw sewage, pretreated only by coarse screens. In design they are doubtless very similar to those in use in Iowa.

Since the sand is in most instances shipped, more care is given to its selection than would be the case were it available locally. Usual specification requirements call for a sand having an effective size of not less than .3 mm. nor more than .45 mm. and having a uniformity coefficient of not to exceed 2.5. Since it is very desirable that the fine material be kept at a minimum, requirements as regards limiting percentages of fines are sometimes included. Some engineers specify that not more than 1 per cent of the sand shall be finer than .13 mm. Where bank sands are used, it is very important that a turbity measurement be made and the permissible turbity sharply limited.

In one or two Kansas plants, an attempt was made to economize on first cost by using a locally available bank sand of satisfactory effective size and uniformity coefficient but having a high silt content. Subsequent operating experience at these plants would indicate that if such sand is to be used, it should be washed. By washing, it would also be possible to remove some of the undesirable fine sand particles. The presence of the fine sand and silt undoubtedly greatly decreases the size of the void spaces and consequently the capillary retention of sewage in the sand is increased, with a resulting loss of oxidation capacity.

In this connection, it is interesting to note changes that have taken place in the design of sand filters as regards underdrain spacing. Better underdrainage is now provided usually with gravel or broken stone covering the bottom of the bed at east to the depth of the drains, and, many times, deeper. The reduction of the underdrain spacing from 10 ft. to 15 ft. spacing to 5 ft or 6 ft. is also a desirable improvement. Six-inch tile are more frequently used than 4 in. for underdrains and with ventilating risers at both upper and lower ends of the underdrain lines excellent aeration of the bed is secured.

It sometimes happens that during high water the outlet from a sand filter is submerged, backing flood water through the underdrains up to the bottom of the filter. The clogging from mud thus deposited can be very troublesome. Where there is any chance of back water damage, protection should be provided by flap valves controlled by a float or other device of positive action.

The banks around the sand bed should also be protected from erosion and the resulting silting up of the edges of the filter. In all but two or three of the Kansas installations, the banks around the filters are surrounded by a concrete wall high enough to protect them from surface wash.

Because of the cost of sand, there is a tendency to reduce the depths of the bed below 36 ins. and even below 30 ins. Such reduction in depth must carry with it design that will provide for the uniform distribution of the sewage over the surface and the proper aeration of the filter for its entire depth or else we may expect less satisfactory results. While underdrainage has been improved, there has been perhaps less attention

given to the securing of uniform distribution of sewage over the surface of the sand. The earlier elaborate systems of wooden flumes were difficult to keep in order and tile lines placed on the sand surface are hard to maintain. It would seem well to plan the distribution system so that the operator can with little trouble change the rate of application of sewage to different parts of the bed. The use of an open concrete flume with adjustable lateral ports either discharging through overflow troughs of wood or half tile placed on the sand surface or onto well baffled platforms, seems to be a very satisfactory method of distribution. There are many types and arrangements of distribution systems in use and their satisfactory or unsatisfactory behavior under operating conditions is the determining factor of their success. Where climatic conditions make it necessary to ridge and furrow or mound a filter for winter use, it is desirable to be able to do this work with a minimum disturbance of the distribution arrangement.

The amount of sewage applied at one dose is somewhat varied in practice. If it were possible to secure uniform distribution of the sewage over the sand surface with a small dosage, then an application of 1 in. of sewage at a time would be desirable. Because of the unevenness of a bed and other difficulties of uniform distribution, a larger dosage is more frequently used with a correspondingly larger interval between applications. Three inches is regarded by many as being a practical maximum limit for a single application of sewage. Such an application is at the rate of approximately 80,000 gals. per acre. In order that the sewage does not become over septic in the dosing tank, it is necessary to make the filter areas smaller when designing for large dosages. As to the amount of sewage that can be applied, much depends on the clarification of the sewage and the quality of sand used. In a sewage well clarified and containing only domestic wastes, good results have been obtained from filters operating at approximately 200,000 gals. per acre per day. Better operating practice would perhaps limit the maximum rate to 150,000 gals. per acre per day.

When used as a final process following other secondary treatment, the sand filter can be operated at rates much higher than are possible if the filter is to have the full oxidation load.

It is probable that sand filters for secondary or oxidizing treatment will continue to be popular, especially for the moderate sized plant or in places where odors prevent the use of sprinkling filters. The choice will depend largely on the availability of suitable sand, terrain limitations and other economic considerations.

GRIT CHAMBERS AND SEWAGE SCREENS

By Howard R. Green, Consulting Engineer, Cedar Rapids, Iowa.

(Presented at Eighth Conference on Sewage Treatment at Ames, Iowa, November, 1926.)

The annual conference on Sewage Treatment is held for the benefit of those city and town officials of the State of Iowa interested in the operation of sewage works already constructed. In this discussion of Grit Chambers and Sewage Screens, therefore, an effort will be made to present useful information in non-technical form. As by far the majority of plants now in operation in Iowa serve municipalities with populations ranging from five hundred to two thousand, emphasis will be placed on equipment of types and designs usually found in installations of relatively small capacity, suitable for such communities.

The use of grit chambers and coarse screens usually forms the first step in sewage treatment, regardless of the size or type of the plant. Generally speaking, they are used in conjunction with the plant for protective purposes; that is, to free the sewage entering the plant from such material as would injure pumps or other machinery, or interfere with the proper progressive treatment of the sewage. In other words, the grit chamber is designed to remove sand, stones, and similar heavy materials, while the coarse screen removes the large lighter material, such as sticks and rags. Either of these classes of matter would injure pumps or fine screens, and heavy mineral matter in any quantity hampers the digestion and pumping of the sludge, while the lighter material helps to form a floating scum which is to be avoided.

Many of the older sewer systems were a combination of sanitary drains and

storm water sewers. They not only carried off the household wastes, but took care of the surface water from the streets as well. The first street washings of each storm carried great quantities of sand and pebbles. It was, of course, necessary to remove this heavy material before the sewage entered the treatment works proper. Also at times of heavy rainfall the sewers flowed full and the velocity was high. The only way to remove these heavy solids was to slow up the velocity sufficiently to allow the stones and sand to settle out. This was accomplished by running the sewage through a small tank or grit chamber which served to widen the area of flow, checking the speed or velocity, whereupon the objectionable material settled to the bottom and the sewage passed on through to the tanks. If this grit chamber was designed to serve its purpose during times of heavy rainfall when the rate of flow was high, trouble was encountered during dry seasons, when no storm water was running and only domestic sewage was carried by the sewers. A grit chamber big enough to slow up the heavy storm water run-off would during the dry season slow the smaller flow of domestic sewage to such an extent that organic matter would settle and become septic. The grit chamber then became a miniature septic tank, interfering with the delivery of fresh sewage to the main tanks.

Under today's conditions, nearly all our sewerage systems have been separated so that the storm water is disposed of in one system of sewers, and the house drainage and industrial wastes in a separate system. The quantity of stones, sand and grit in the sanitary sewer system is, therefore, greatly reduced and the variation in flow during rains is not nearly as marked as it is in the combined system. A considerable quantity of grit still finds its way into the sanitary sewers through vent-holes in street manhole covers, from automobile wash-racks, etc. The grit chamber is still a necessity, though a troublesome one.

The average sewage disposal plant is designed to care for the entire population within the sanitary districts, and the several units of the plant are amply large to take care of the situation when all houses have been connected with the sewer system. Yet, during the first few years of a plant's operation, the quantity of sewage reaching it is only a small proportion of its capacity. During these first few years, the rate of flow is small. The velocity of the sewage passing through the grit chamber is therefore low, and as before stated, organic matter is deposited and the grit chamber becomes septic.

Quite often no means of cleaning the grit chamber except by shoveling is provided. The result is that it is seldom cleaned. The actual grit is mixed with foul-smelling organic matter and usually no means of disposal is provided. You have no doubt seen grit chambers so clogged with sludge and scum that only a narrow flow area was left for the sewerage to pass through, thus defeating its purpose and rendering it the foulest place about the plant. Some grit chambers are provided with a valved outlet and a by-pass line to the outlet stream, whereby the operator can drain them frequently during times of high water when the filth will be carried away without apparent damage. Other plants have no river or stream outlet, hence no such easy way of disposal presents itself.

I think our tendency as engineers is to design grit chambers too large. I believe that if half the grit chamber area in most of the plants I have seen, including those of our own design, were walled off and the capacity cut in half, the grit would still deposit and a great deal of the organic matter would not. In some cases, this could easily be done by providing duplicate chambers, one to operate while the other is being cleaned. The discussion of the disposal of the grit chamber sediment will be left until the matter of screens has been discussed.

Sewage screens are of two general classes; coarse screens for the removal of sticks, rags and similar foreign materials; and fine screens for the removal of as much organic matter as possible. Coarse bar screens, or gratings in conjunction with grit chambers are good insurance for the satisfactory operation of the balance of any plant, small or large. Fine screens, mechanically operated, are advisable only in large installations warranting the constant employment of caretakers. Screens having coarse openings larger than one-half inch are usually termed "coarse screens," although most coarse screens have one-inch openings or larger.

There are four general types of fine screens: the band screen, the wing

screen, the drum screen and the inclined disc screen. The band, or revolving screen, consists of a broad belt of fine screen material running over two broad rollers, which are power-driven. The lower roller is of open construction and offers but little resistance to the passage of sewage through it. It is set well below the level of the sewage in a rectangular shaped flume or channel. The upper roller is set well above the level of the swage and the revolving belt connects the two at an angle of about thirty degrees with the horizontal. The rollers revolve and the up-stream belt moves slowly upward as the sewage passes through, carrying the screened material on its surface. A revolving brush near the upper roller cleans the belt screeen and deposits the screenings in a trough rady for disposal.

The wing, or shovel vane screen, operates like the stern paddle-wheel of a river steam-boat, the paddles being replaced by fine screens and the wheels set across the sewage channel. The floor of the sewage channel is hollowed out, so that the edge of the screen makes a close contact with it, forcing all the sewage to pass through the screens. These paddle screens are cleaned by brushing after they have reached the point above the sewage level.

The drum screen is a long revolving cylinder. The sewage flows into one end of this cylinder and as it rotates the screenings are carried upward and dumped on a conveyor which runs through the cylinder near the top from end to end. The screen is cleaned by jets of air or water.

The inclined disk-end cone type consists of a large circular disc of perforated brass set down in the sewage channel on such an incline that its upper half if above the water level. As the disc revolves, the sewage flows through the fine slots in the disc, and the screenings are carried up above the water level and brushed off by revolving brushes.

In the majority of installations, these fine screens find a variety of uses. Sometimes they precede the further tank treatment and in some cases they are located between the tanks and trickling filters for the purpose of reducing the amount of clogging in the nozzles.

In the last analysis the problem of the sanitary engineer is to remove objectionable matter from sewage at the least possible cost Each city or town has its separate problem. In many cases the fine screen has proven its worth, though they are not generally necessary or adaptable to the majority of small town plants thus far constructed in Iowa, and they are therefore simply mentioned in passing.

There are two general types of coarse screens: the rack, and the grating. You are all familiar with the rack. It is simply a series of parallel bars or rods extending from well above the sewage level to the bottom of the rectangular channel through which the sewage is flowing. The grating is built and placed in the same manner, except that it has cross bars at frequent intervals, reducing the size of the screen openings. The rack type predominates.

As before stated, the coarse screen is usually set in connection with the grit chamber, and sometimes between the grit chamber and the tank, the latter location seems to be advisable. Sewage passing through the coarse screen often eddies, and these eddies tend to cause a deposit of the heavier organic matter. The chance of this deposit occurring in the grit chamber where it is not wanted is less if the screen follows the grit chamber than if it precedes it. Set at an angle of about thirty degrees with the vertical, the rack type of coarse screen is easily cleaned with an ordinary hand rake, so constructed that its teeth mesh with the bars of the rack. They should be cleaned at frequent intervals.

A clogged screen causes organic matter to deposit in the grit chamber. It frequently raises the water level in the grit chamber to such an extent that the sewage is backed up in the inlet sewer for a considerable distance causing deposit of sludge in the sewer itself, and the formation of scum. I have seen a serpent of scum six hundred feet long come winding out of an inlet sewer when a screen was first cleaned and the water level lowered.

And now comes the question of how to best dispose of the screenings and the accumulations in the bottom of the grit chamber. Operators have told me that they raked the screens regularly and put the screenings over into the main tank as being the easiest way of getting rid of them. In such a case, the screen is a nuisance to the operator and of no benefit to the plant. While the trash on a coarse screen or on the bottom of a grit

chamber is not strictly sewage or sludge, it is so saturated with organic matter, partially decomposed, that it is offensive to the eyes and nose and can not well be drawn out on the sludge drying bed. The best solution of the problem is to dig a pit near the grit chamber outside the plant and bury the trash, covering it well with earth.

For small plants a pit four feet square and five feet deep will take care of several months' accumulations without offense and without any great expenditure of labor. The cleaning and burying should be done at regular intervals of, say, once in two weeks in the plant caring for populations of from eight hundred to one thousand. There is much more chance of getting this work done in frequent installments which do not call for much labor, than there is of getting a nasty, distasteful job of considerable size done once a year. The only tools necessary are a garden rake with teeth properly set, a square end shovel bent to scrape the bottom from above, and a galvanized bushel basket. This work is just as essential to the complete and proper operation of the plant as any other single detail.

Like many other details of plant operation, the care of the grit chambers and sewage screens is a small matter if attended to, but a big item if overlooked.

THE TOLL BRIDGE MENACE

From "American Highways" for April, 1927.

Covered wagons and covered bridges belonged to the same era, but a purring auto and a toll bridge do not.

Bridges are a necessity. Privately owned bridges, located at strategic points, carrying 30-year franchises, are a private snap. Our much vaunted cry that the highways of the nation are open and free to everyone is in danger of becoming a misnomer. Modern highway financing presumed that the motor license and gas tax were the only special revenues needed to pay for improved highways, but now we are told that this will not build the necessary bridges and the only way to take care of the situation is to give a long-time, gilt-edge franchise to certain engineering and bonding concerns, who will take these jobs off our hands. We won't need to worry over construction costs, upkeep of bridges or interest items. All the people will need to do is to pay a toll and go on their way rejoicing.

During the Sixty-ninth Congress bills were passed granting franchises for the construction of bridges totaling 163, of this number 53 are franchises to private parties for toll bridges. There was a special rush to get franchises during the last 90 days of the Congress. In that time over 50 per cent of the bills passed were for toll bridges to private parties or corporations.

How many requests for franchises were defeated is still another story.

A Promoters' Gold Mine

For several years past the States, in cooperation with the Federal Government, have been busy constructing a system of roads that will connect all the market centers of the country. The work has progressed rapidly and well. This fine network of highways is uniting and many communities previously strangers to each other, as their transportation methods used, whether by rail or water, have led into other directions. This system of highways has made evident opportunities for bridge construction heretofore unnoticed.

Parties, either in the capacity of consulting engineers, or bond brokers, have been traveling over the country hunting strategic points where bridges should be constructed and either appearing before the Congress for franchises without local pressure or, as in other cases, securing support of local commercial clubs, etc., on the ground that a bridge at that location will bring more town trade and the community will not be agreeable to a tax levy or bond issue to furnish the finances for the bridge.

In one case recently an engineer even went on the witness stand where some legal difficulties were being ironed out so that two adjoining States could build a free bridge, and endeavored to "queer" matters so that private concerns could secure a toll franchise.

When the State and Federal authorities, who are responsible for the expenditure of public funds, began to protest against this wholesale granting of franchises for toll bridges on too generous terms without any protection to the public in the construction of these bridges, which ultimately must become public property, these exploiters formed a national organization at St. Louis on January 17 last to "protect" their interests.

Toll Bridges a Financial Snap

Toll bridges are not a new thing in highway financing and have always been "a money maker" for the owners.

In a midwestern state efforts have been made by the state officials to purchase certain privately owned toll bridges. An investigation showed that a bridge capitalized for $50,000 had a net income in 1926 of $25,910.51; another one capitalized for $120,000 showed a net profit for the year ending December 31, 1925, of $53,440.22. Still another one whose capital stock is $60,000 admitted gross receipts in 1925 of $38,000.

In a state on the Middle Atlantic Coast the highway department recently expressed a desire to purchase for the public a certain toll bridge. The owners wanted $85,000 and admitted a net profit last year of 33 per cent on that valuation. The state closed the deal for $55,000 only because it was in a position to make another interstate road connection with the adjoining state on the interstate system and eliminate this location entirely.

These are a few of many cases scattered throughout the country, showing the big profits made off the general public who yet are compelled to patronize them.

Some Toll Bridges Necessary

If the public wants bridges faster than a tax levy will construct them, the only other recourse is a bond issue. But why give the job of selling the bonds to private concerns, who, when the state does take over the bridges, are in a position to demand an extra profit. If you *must* have a bridge and it *must* be a toll bridge, let the state make the profit and not a few individuals.

The Legislature of Tennessee recently authorized the issuing of $5,000,000 in bonds for the state to build toll bridges.

A state-owned toll bridge will become a free bridge much sooner than if it is a privately owned toll bridge. Every toll goes toward the retirement of the bonds and none into the private bank accounts of individuals.

Present Law Inadequate

The present Federal law controlling the granting of franchises over navigable waters makes no requirement for supervision of the construction of a bridge or the maintenance of a bridge after it is once constructed. The Federal Government grants franchises because it has control of the navigable waters, but it is only interested in the location and plans for the bridge insofar as it may affect interstate commerce.

At no time does the Federal Government contemplate ever purchasing, for Federal ownership, a toll bridge. This is looked upon as a state responsibility. Being a state responsibility, the state should have supervision over the construction and maintenance of a bridge which at some future time is bound to become state property.

Remedial Legislation Asked

During the last session of the Congress just closed a bill, sponsored by the American Association of State Highway Officials, was introduced by Representative O. B. Burtness, of North Dakota, which proposes to make certain amendments to the present General Bridge Act and adds features which will protect the public in the granting of franchises. There was no opportunity to hold hearings on this bill, but it will be reintroduced in the next Congress, and its merits made known to those who are responsible for Federal legislation. The public press is already awake to the situation and large business concerns as well as the traveling public expect to be heard.

Outline of Proposed General Bridge Act

The following is a synopsis of the proposed legislation to control the granting of franchises for free and toll bridges and supervise the construction and maintenance thereof:

Section I

Consent of the Congress is given to erect bridges over navigable streams under the following provisions:

1. Secretary of War must approve location and plans so far as they are affected by navigation.

2. Bridge privately owned on system of state highways shall not be constructed until location, design, plans, contract, etc., are also approved by state highway department.

(a) If located between two states, both states must approve.

(b) If states can not agree, the Secretary of Agriculture shall make final approval.

3. Erection of privately owned bridges shall be inspected by the state highway departments and maintenance of such bridges shall be subject to inspection and satisfaction of the state highway departments.

4. No tolls can be collected until above provisions are complied with.

Section II

The Secretary of War shall have authority to compel those having supervision of any bridge constructed under this act to revise or make changes to meet navigation conditions.

2. Operation of draw bridges and the maintenance of lights, signal, etc., shall be under regulations prescribed by the Secretary of Commerce.

Section III

1. Toll rates shall be reasonable and when collected for privately owned bridges they shall be limited to yield not to exceed 10 per cent net per annum on the actual cost as determined by the authorities designated in this act.

2. Bridge tolls over bridges wholly within one state shall be controlled by state highway department or other board so designated by state law.

3. Bridge tolls on bridges on state lines shall be regulated by state designated authorities, and in case they do not agree the tolls shall be fixed by the Secretary of War.

Section IV

1. States or political subdivisions may erect toll bridges under regulations already described, and tolls shall not exceed amount necessary to retire cost funds and maintenance within a period of not to exceed 25 years. After that time such bridges must be free of tolls.

Section V

(a) Secretary of War may give permit for the erection of a toll bridge by private parties when the state highway department of the state affected certifies to him that the state is not in a position to finance such bridge.

(b) Power is given to secure real estate and other property needed for location and construction of bridge under laws of the states concerned.

(c) States or political subdivisions may take over privately owned toll bridges at any time under condemnation proceedings or may take over said bridge 10 or more years after completion and compensation therefor shall be limited as follows:

1. Actual cost, less reasonable deduction for depreciation.

2. Actual cost of acquiring interests in real estate.

3. Actual financing and promotion costs not to exceed 10 per cent of cost of construction and real estate acquired.

4. Actual expenditures for necessary betterments and improvements.

(d) If state takes over toll bridge and charges toll, said tolls shall be limited to funds necessary to provide sinking fund and maintain bridges, but in no case shall this condition prevail beyond 25 years.

(e) 1. Within 90 days after privately owned toll bridge has been constructed said company shall file complete sworn report of cost of construction with the Secretary of Agriculture if the bridge is on state line, otherwise report shall be filed with the state highway department.

2. The Secretary of Agriculture or the state highway department, as the case may be, shall, within one year after company report has been filed, investigate the books of said conmpany, and the findings as to actual cost of construction shall be conclusive, subject only to review in a court of equity for fraud or gross mistake.

(f) The right to sell, assign, transfer or mortgage is granted, except no remuneration shall be received in case of transfer of authorization for the construction of the bridge only.

Section VI

Books of state or corporation operating toll bridges shall be open to inspection by the state highway departments, the Secretary of Agriculture, the Secretary of War, or their accredited representatives.

State highway departments are authorized to prescribe uniform method of accounting.

Section VII

Penalty for violation of the navigable features of this act.

Section VIII

It shall be necessary for the Secretary of War to grant extension of time if construction of the bridge has not been begun within one year or continue such

construction after the expiration of three years.

Section IX

Definitions of terms used in this act.

Section X

This act applies to all bridges proposed for construction over navigable streams and any future reconstruction or alteration on bridges heretofore authorized by the Congress or a state legislature in accordance with this act.

Section XI

This act does not authorize the construction of any bridge between the United States and any foreign country. Such bridge must first receive special congressional approval.

Section XII

Penalty for violation of the general features of this act.

Section XIII

The right to alter, amend or repeal this act is reserved, and the United States incurs no liability for the alteration, amendment, or repeal thereof.

Section XIV

Repeal of act of March 23, 1906.

Section XV

This act shall be cited as the General Bridge Act.

HIGHWAY BRIDGE PRACTICE IN MASSACHUSETTS

By Albert E. Kleinert, Jr., Asst. Engineer, Massachusetts Department of Public Works, Boston, Mass.

(Paper presented before Highway Section of Boston Society of Civil Engineers.)

The development of the motor vehicle has created a strong demand for roads and bridges which are capable of carrying heavy loads and fast pleasure cars. After considering the 2,000 or so highway bridges in Massachusetts, one must form the conclusion that many must either be rebuilt or replaced before this demand is met. This is the work of the bridge department of the division of highways of the Massachusetts Department of Public Works, and includes briefly the inspection and investigation of existing bridges, the design for their reconstruction when advisable, the design and supervision of construction of all new state highway bridges, advice to towns on bridges within their jurisdiction, and the approval of all designs for highway bridges made by private engineers for cities and towns. Included also are the designs for structures in connection with highways, such as culverts and retaining walls whenever the same are other than standard.

No existing bridge is replaced until it has been inspected and studied to see if it can not be reconstructed in some manner to enable it to meet the present-day requirements. However, the usual result of such an examination favors a new bridge. There are several reasons for this. The first is probably the condition of the structure; the second is that the original design was for lighter loads; the third may be that the approaches were safe for the days of horse-drawn vehicles, but are entirely unsafe for motor vehicle velocities; and the fourth, that it may cost more to repair and reconstruct the old bridge than it would to build a new one; and so on. Thus there are numerous reasons for replacement.

In planning a new bridge, certain desirable features should be kept in mind. The line and grade are sufficiently important to receive much attention. If at all possible the bridge should be on a tangent. The grade is best when it is level, or is a continuation of the grade of the approaches. Of course there are cases when ideal conditions can not exist, such as the elimination of a grade crossing for a railroad where it is necessary to allow at least an 18-ft. clearance over the rail, or where a river has considerable ice during the spring floods and it is necessary to clear these floods, or where it is impossible to cross a river without a curved alignment due to the existence of high embankments above the road on both sides of the river. Bridges have been built on curves, but not until the engineers were convinced that nothing could be done to prevent it. The material to be used for the construction of the bridge is often a cause for study.

For Massachusetts practice, reinforced concrete is usually used for spans up to 50 ft., and steel for spans greater than this. Somewhere near this length the economy of concrete, due to its very low maintenance cost, is offset by the

increased initial cost resulting from its own weight. Low maintenance and permanence are the two outstanding advantages of concrete, which have made it so popular as a material for highway structures.

Reinforced Concrete Bridges for Spans Under Fifty Feet

The ordinary design for a reinforced concrete bridge with less than a 50-ft. span, consists of a number of parallel T-beams supported by the abutments. The flanges of the beams form also the floor slab. A curb from 10 to 12 in. high is poured integrally with the slab and beams along both sides of the bridge. This curb serves as a base for the fence which is poured later, or, as is sometimes done, the panels of the fence are pre-cast and placed between the posts at a later date. For a wearing surface a 2-in. layer of the Massachusetts Specifications Type "D" bituminous concrete is the prevailing custom, because of its light weight and its excellent wearing qualities. To use a gravel fill and a surface of bituminous macadam adds over 100 lb. per square foot of dead load to the structure. This seems an unnecessary addition when there is available an entirely satisfactory surfacing at a much less weight. It is a practice to waterproof the floor surface before adding the wearing surface. This tends to keep the concrete dry, or at least prevents excessive changes in the moisture content. The simplicity and efficiency of this T-beam type of concrete bridge have been proven by the popularity it is having.

In some of the rural sections of the state, small bridges are often necessary along roads carrying only local traffic. To meet the demand for replacements here, a flat slab is used for spans up to 15 feet, and steel beams supporting a flat slab are used for longer spans. These are economical because local labor may be called upon to carry out the construction, since the forms are simple to build, and the I-beams are not difficult to place. Concrete curbs 10 to 12 in. high on each side of the bridge support the fence, which for these types is either entirely of wood or wooden rails on iron uprights. Frequently the abutments require but little new construction, and all that is necessary is a new concrete parapet about 12 in. high to support the end of the bridge slab.

Steel Bridges for Spans Over Fifty Feet

Steel bridges for spans over 50 ft. may be divided into three groups—the plate girder, the pony truss, and the through truss. Plate girder bridges have been used for spans up to 90 ft. Railroad underpasses or overpasses usually are surrounded by conditions which are best met by the plate girder bridge. Several of the recent bridges carrying the highway over a railroad have required a minimum depth for the floor system. To meet this demand plate girders were used with a floor system made up of heavy rolled sections spaced from 3 ft. to 6 ft. on centers, for floor beams without stringers. One of these bridges, with the girders spaced 44 ft. 8 in. apart, had the grade of the road 22 ft. 6 in. above the top of the rail, with a railroad clearance of 18 ft. This leaves 4 ft. 6 in. from the bottom of the concrete protection for the girders to the top of the center line of the road. The saving on the fill for the approaches more than offsets the cost of the additional steel used for the bridge. Some railroads require a concrete protection 3 in. thick on all vertical surfaces and 4 in. thick on horizontal surfaces. It is readily seen that this requirement adds considerably to the dead load of the structure.

Pony truss bridges have been used for spans up to 120 ft. Like the through-truss highway bridges, their design has been very much like the standard truss highway designs. One variation worth nothing is the concrete slab floor. All new steel bridges have a reinforced concrete slab floor spanning from stringer to stringer. A 2-in. Type "D" bituminous concrete surfacing is the common wearing surface. This floor and surface weighs much more than the old wood planking, but the additional weight is unquestionably worth the extra cost.

Among the types of bridges which are less frequently built are the reinforced concrete arch, the pile trestle, and the wooden truss. The concrete arch requires a foundation which is capable of resisting a horizontal thrust of considerable magnitude. Unless a material such as ledge is available for a foundation, the cost of building a rigid support for the arch makes the total cost of the bridge uneconomical, and other types are chosen. A second obstacle in the path of the designer who is partial to arches is the ever-present

skew. There are few highway bridges in Massachusetts which have abutments at right angles to the superstructure. The angle is usually from 80 to 40 degrees, and averages about 60 degrees. This condition, of course, adds to the difficulties of design, and likewise to the cost of the bridges, due to the additional length of the abutments.

Types of Abutments

Two types of abutments are in vogue at present; one is the gravity and the other the reinforced concrete. They are used in accordance with the dictates of economy. Up to heights of 14 ft. the gravity type is most frequently more economical; higher than this reinforced concrete walls show a saving. Boulder concrete is used for the gravity wall and is, of course, much less expensive than the 1:2:4 mix specified for the reinforced concrete. In cases where the wall is subject to tidewater, a granite facing is necessary for that section of the wall which is alternately wet and dry. The salt water reacts upon concrete between high and low water, and granite is the best form of protection now known to prevent the deterioration of the concrete. The facing makes it advisable to use a gravity wall, for the reinforced concrete wall is seldom thick enough to take a facing. There are two methods of designing the reinforced wall: The first is the cantilever or T-wall; the second is the counterforted wall. The latter has the advantage of greater rigidity; the former is more economical because of more simple forms. All the walls described above have been used for abutments, and it is difficult to exclude any one of them from consideration when determining the type of abutment to design.

Reconstruction of Steel Through-Truss Bridges

It has already been stated that the usual result of an investigation of an existing bridge, favors a new one. The bridges which prove to be worth reconstructing are the steel through-truss bridges. These were designed for a uniform live load or for a single concentrated live load, depending upon which gave the worse condition. Naturally the uniform load produced the maximum stresses in the trusses, and sometimes in the floor beams. When the stringers were designed, the concentrated load governed, and it is here where most of the trouble lies. The concentrated load of 25 years ago was usually a steam roller weighing about 15 tons, 9 of which were on the rear axle and 6 on the front. If the load on the rear is divided equally between the rear wheels, there will be a load of 9,000 lb. on each. Designs to carry the auto truck of today are figured upon 20-ton trucks, of which load 40 per cent is considered as concentrated upon each rear wheel. This amounts to 16,000 lb. and when compared with the 9,000 lb. for which the stringer has been designed, we may readily understand why this number is light. The other members of the bridge are frequently strong enough to carry the loads without excessive fiber stresses. The method of reconstruction, then, is to replace the entire flooring and stringers with stronger designs. This calls for heavier stringers, new yellow pine spiking pieces, new yellow pine sub-flooring 4 in. thick, a water-proofing covering, 3-in. wood block, new yellow pine wheel guards, and other miscellaneous accessories. All wood used must be treated with creosote. All steel parts of the structure receive a thorough cleaning and painting before being covered over with the new floor. Care must be taken to see that the increase in the dead loads due to this new construction does not unreasonably reduce the live load capacity of the structure.

It must be kept constantly in mind that the total capacity of the bridge is constant, and that an increase in the dead load produces an equal decrease in the live load. It is this limitation which prevents the use of a reinforced concrete slab for a floor on our old bridges. Wood block is used instead, because of its light weight. However, there are certain drawbacks to its use. Care must be taken to see that the blocks will remain in plate. Excessive stringer deflections and floor vibrations will cause trouble and ultimately ruin the surface. It is wise to keep the deflection as small as possible. No trouble has been reported so far in the case where the deflection was computed to be 1/720 of the span, and this is a good maximum limit to have. Vibration may be reduced by making the structure as rigid as possible. A step in this direction is to frame the stringers into the floor beams instead of supporting them on top. With deflection and vibration provided for, the laying of the wood block is similar to the standard practice for this surfacing. Expansion joints of

bituminous materials are placed longitudinally along the edge of the road. A similar joint is placed transversely about every 100 ft. When the span is a long one, a small angle iron reaching from curb to curb is bolted to the sub-floor, with the upright leg just below the tops of the blocks. These are placed about every 30 ft., and prevent the crawling of the blocks in the direction of the traffic. If the blocks are held in position no trouble may be expected. Several bridges have been repaired and resurfaced with wood block within the past few years, and so far this method has been considered successful.

Continuous Bridges

There is a growing tendency toward the design of continuous structures for highway bridges. Continuous beams for two and three spans are being used. Their economy is established. The types having the abutments continuous with the superstructure have not been accepted and built as yet in Massachusetts, other than for a few short spans. There is still much to be done in developing these designs, but it is only a matter of time before we may benefit from their advantages.

The architecture is also receiving its share of attention. Improvements have been made in the appearance of the bridges. The most noteworthy is, perhaps, the adoption of the so-called "openwork fence." Instead of the old solid panel, the new panel has a series of openings 6 in. wide by 2 ft. high, with a semicircular top, spaced about 12 in. on center. The idea has been to improve the appearance of the bridge without spending extra money. What kind of bridges will be built 25 years from now is difficult to say; but we do know that remarkable advances have been made during the past 25 years, and that there is still room for further improvement.

ARBITRATION CLAUSES IN CONSTRUCTION CONTRACTS

By E. W. Reaugh, President Reaugh Construction Co., Cleveland, Ohio.

(From "The Constructor" for November, 1926.)

It is difficult to turn to any phase of business these days without running across some approved recognition of the principles of arbitration. In our own business, which more than anything else is the entering into, and the performing of, contracts, we find arbitration recognized and approved by one of the largest and most representative and capable groups of men and organizations that ever got together to develop a standard business document. The group of men who did this work completely represented every phase of the construction industry.

After more than ten years of study and advice and legal interpretation, and after several years of practical operatoin under this carefully developed arbitration clause we find it again approved this past year and written into the Standard General Contract document copyrighted by the American Institute of Architects as their fourth edition, which just recently has come into our hands.

Reasons for Acceptance

Although we have now reached a point where the acceptance of this principle is almost universal, still, so long as there is an occasional one to be found who has not yet been converted, it can do us no harm to review its growth during the past few years and some of the reasons which have been largely responsible for this almost universal acceptance. In fact, by doing so we serve to refresh our minds and fortify ourselves against the occasional attacks that may be made upon it by the occasional irreconcilable who still seems to cling to some phases of the theory that "Might makes right."

Various Provisions

Arbitration is a term applied to an adjudication by persons called arbitrators, appointed to decide a matter in controversy by the agreement of the disputants. In several states it is provided for by statutes, and in some the submission must be in writing. In New York the legislature established a court of arbitration. In these states a submission to arbitration may be made at any time if the case is not in court. At Common Law, where a case was pending, submission might be made by rule of court before the trial or by a court order after it commenced. This mode of settling disputes has been approved by the legislatures and by our highest judicial tribunals. There are but few matters that can not be made the subject of arbitration and they have been clearly set out by long lines of court decision. They are:

1. Cases where one of the parties is an infant or a person incompetent to manage his affairs by reason of lunacy, idiocy or habitual drunkenness.

2. Where the controversy is in connection with a claim to a permanent estate in real property.

The arbitrator ought to be a person who stands perfectly indifferent between the disputants. In some states the arbitrator is required by statute to take an oath to hear faithfully and fairly and examine the matters in controversy and to make a just award according to the best of his understanding.

International arbitration has been discussed freely and at length and it has been employed in matters of debate between nations more than one hundred times. The first general treaty of arbitration ever drawn between nations was signed January 11, 1897, in Washington by Richard Olney, Secretary of State for the United States, and Sir Julian Pauncefot, for Great Britain. The International Peace Conference at The Hague, in 1899, established an International court of arbitration, which has been ratified by the United States and other signatory powers.

Many Misunderstandings

In construction contracts many misunderstandings arise, and when litigation is necessary it means a law suit and creates a large expense in both money and time, and the best that can be hoped for by either party is a decision by a jury made up of many who do not understand the construction details. Many provisions in the ordinary specifications and in the so-called contracts used on some construction operations have been proved illegal, and this in spite of the fact that they were drawn with the greatest care and caution by well-known attorneys, acknowledged to be clever and wise in their profession. If any one questions that statement I shall be very glad to discuss it further, for I have with me copies of certain court records that bear out that assertion. In fact, there is one of these cases decided so recently and outlined by the New York Supreme Court judge who wrote the decision with such clear understanding that I want to quote a small portion of the decision to you.

This was a case where a contractor had signed one of these so-called tight contracts that placed full authority in an engineer representing the owner. The language of Supreme Justice Crain is as follows:

"The contract was drawn with care and apparent skill to safeguard the interests of the city. It was not prepared with a view to protect the interests of the plaintiff contractor. A less one-sided contract might have been productive of good will and mutual helpfulness and cooperation. The contract as drawn and interpreted by the commission and its engineer engendered disagreements and ill-will. Induced it may be by its one-sided and unbalanced provisions which were inserted to confer upon the city rights and remedies which it otherwise would not have had and to take from the plaintiff contractor rights and remedies which it otherwise would have, had the engineer in the exercise of the sweeping powers given to him by the contract conducted himself from the date of delivery of the contract to the date of the acceptance of the work in careless disregard of what might retard the progress of the work. With respect to the furnishing by him to the plaintiff of amplifying drawings as required by plaintiff and with respect to his approval or disapproval of shop drawings submitted to him by the plaintiff he acted with indifference to the rights and interests of the plaintiff and with a disregard of his duty and the city's obligations under the contract. As a result the plaintiff contractor started and progressed, the work handicapped and retarded by the delays and inactivities of the engineer and his oft repeated revisions of the amplifying drawings. On the one hand, the plaintiff was required to do certain things and on the other hand it was forbidden to do them unless and until it obtained the required drawings from the engineer. The drawings which were asked for first were furnished last; those which it did not at the time need and could not at the time use were given it. The plaintiff's iron and steel construction were held up by its inability to furnish its subcontractors with working drawings and these it could not furnish because the engineer delayed beyond the stipulated contract time in acting upon them. The plaintiff was forbidden to proceed with its excavation work until it was ready to go ahead with the steel construction and from the very nature of the case it could do no concreting except foundation work until the steel was in position. The plaintiff could not go through the block owned by pri-

vate parties, through which the contract required it to tunnel, until the easements therein had been acquired by the city. These were not acquired until some months after the period when the plaintiff was required by the contract to begin its work. The contract by express provision relieved the city from what would otherwise have been its liability, but the provisions of this contract can not stand. The contractor has redress and the city is not exempt from liability regardless of the pains taken by those who drew and those who approved the contract and put into it the clause seeking to exempt the city from liability."

"Mistaken Idea"

I think there are some architects who have a mistaken idea as to the importance of these so-called contract documents that set up one man with a fixed interest and bias to act as the sole authority for the interpretation of disputable specifications, conditions and provisions. Occasionally an architect is found who seems to think that because the specifications are so drawn as to admit of two interpretations, and because they have a special form of contract drawn by an attorney in whom they have great confidence, that they have provided themselves with a noose which they can pull at will and use it to frighten the contractor into complying with their own interpretation, which interpretation often times is suggested by the owner. I have no doubt it is true that contractors have been strangled by that noose.

On the other hand, the so-called cutthroat contract has been disregarded in the courts and contractors have been given judgments in full for their claims by the courts. Where the amount is sufficiently large the contractor is justified in going to court. Where it is not, he is often in the position of being literally sandbagged into doing things on a job that rightfully should be classed as extras. Quite often, if the chief architect in the firm were looking after all the details and had full supervision the road would not be quite so rocky for the contractor, but they have field superintendents, and much depends upon the personality and the experience and judgment of the field superintendent, and quite often he is erroneously backed up by the chief architect who feels not only the demand of special loyalty to his client but the necessity for standing behind decisions which have been made by his subordinates in the course of their work. There are not a great many field superintendents who are either experienced enough or diplomats enough to properly handle these items, or who really understand their own real function if they are to be an asset to the job.

There are only a few who devote their efforts and time to studying the job, the plans, and the specifications for the proper progress in an orderly program in order to prevent delay and in order to be in a position to supply the proper information to the job at an appropriate time in advance of its being required. Nevertheless, the chief architect will, in most cases, back up the judgment of a field superintendent who lacks the proper qualifications to analyze a job situation.

The Stone Age has passed, and the Militaristic Age, where "Might made right," is passing. The day has gone when the business man or the business organization who had achieved a place of power could and did say "The Public be damned." We do not so frequently find these days that men or large business organizations attempt to force all that the traffic will bear because they are in a position to force it. We have all progressed. Even men who do general contracting have progressed.

The old layman's conception of the red-necked, shirt-sleeved contractor; the contractor of the old day who guessed at his costs and ignored his contractual conditions and then schemed and devised ways and means of getting by with a profit at any cost to the owner or others interested, has also passed. Today we are very proud of the fact that there is a group of men in this business—40 some in Cleveland, 200 in Ohio, 2,000 in the United States—who have never had a bonding company perform a job; who have never defaulted on a contract; who have never been in the bankruptcy courts; and who are striving to live up to a standard of skill, integrity and responsibility which they have proved over a period of years. This band of Associated General Contractors members has even gone so far as to develop a Code of Ethics that calls for ethical practice, not only between the members of their own industry and profession but if you please, between themselves and

other agencies and professions as well. That code of ethics will, I hope, be the subject of discussion at one of our joint meetings in the future.

The Standard Form

And architects, too, have progressed, and as a national body they have, with a view to maintaining their high professional standards, taken the lead in developing not a document that has in it all that it is possible to compress between its covers that will give advantage to the owner or to the architect, but instead they called into their counsel chambers all the other great national organizations and professional men who knew and understood the hazards and the costs and the pitfalls and the needs of the Construction Industry, and with a desire to write fairness and equitable provisions into a national standard document they developed the Standard A. I. A. Contract form. In doing it they were moved not only by these reasons, but by the very important consideration that unfair practice means increased costs. The A. I. A. is still progressing, and this last 1926 edition, known as the fourth edition of the Standard Documents, endorsed by nine national associations in the construction industry, is the last and a very important indication of that fact.

It is one of the few hopeful highlights in an otherwise very discouraging outlook to men in our business that there are only a few architects in these days who still wish to adhere to the old order of preferring to force the contractor to carry his dispute to court in place of its going to arbitration, where experts can be selected according to the question in controversy instead of having the "butcher and the baker and the candlestick maker" sit as a jury.

You should remember that oftentimes controversies arise with a sub-contractor who has a contract through the general contractor, and then without the arbitration clause the dispute is even more complicated and requires additional and more difficult litigation in the courts.

An Essential Part

The greatest figures in our national and business life agree that the arbitration clause has become a modern essential part of every construction contract. Secretary Hoover in a recent public utterance strongly urged business men and others to take advantage of the Federal and other arbitration statutes as the best possible means of settling their business disputes.

One of the best known lawyers of Minneapolis in a recent speech said that "the best thought of the legal profession is convinced that litigation is not an advantage to clients except under conditions where it is necessary to construe or interpret the law, or where the situation is such that it can definitely settle a legal principle or problem." In all other instances Mr. Deutsch says "all considerations point to arbitration as a means of adjustment rather than litigation."

In almost every large city it requires from ten to eighteen or twenty months to get a case set for trial. There is the cost and the time of rounding up the witnesses and all other business of all parties concerned has to be dispensed with in order to maintain the respective rights in the law suit, and then there is no assurance just when the case will proceed to trial.

Experience has shown that in ninety-nine cases out of a hundred arbitration leaves the parties with a friendly feeling between each other and the opportunities for resumption of uninterrupted business relation instead of the hostilities and severance of those relations as a result of litigation.

We have canvassed our own members and have found just three cases within the recollection of those who have responded to our inquiries where arbitration has taken place. We have talked to attorneys, and it is the profound conviction of these gentlemen that litigation is too costly for all parties concerned if there is any means to avoid it.

One of the disadvantages in the past years has been that when arbitration was provided for in the contract there was no means of forcing the award. Statutes have been enacted in New York, New Jersey, Massachusetts, Oregon and by the United States Congress which will supersede old statutes and make a real Arbitration statute, and matters settled by Arbitration under this new law will, with very little legal red tape and with no delay, be made into court orders. This new statute is to be introduced into twenty-seven states at the next meeting of their legislatures. Ohio is to be one of those states. It ought to be the hope, particularly of every one in the construction industry, that it will be passed

whenever it is introduced. When it is we shall have eliminated another one of the great items that tend to make building costs higher. Furthermore, we shall have eliminated also another one of the elements that sometimes strains the relationships between the various groups that must have almost daily contact in the performance of construction contracts and who, therefore, should strive together to find the way to create harmony and establish good will each for the other.

CITY TRAFFIC PROBLEMS

By William B. Powell, Consulting Engineer, Buffalo, N. Y.

(Address before Engineers' Club of Philadelphia, Jan. 11, 1927.)

The traffic problem is one that we are all in daily contact with. Practically every one drives an automobile today; if they don't at least they have to dodge one when they walk to their place of business, so that we are all in very active contact with this very troublesome problem.

The problem is essentially one of engineering, but it has some collateral relationships which make it a difficult one to handle. It is a political problem quite as much as an engineering problem, and the consequence is the engineer up to the present time, as far as I can see, has not functioned in it nearly as much as he should.

A few years ago when this traffic problem first came upon us rather unawares, with the tremendous growth of the automobile, the first man that came in contact with it, of course, was the man on the street, who was charged with keeping the street in order. That was the policeman, and the police point of view is very different from the engineering point of view. The policeman met the problem as it came to him and did the best he could with it. He was not qualified, either by education or experience, to plan the essentially proper moves to solve the problem, but he did what he could, and was very rapidly overwhelmed. In most cases the natural result was, when they failed with a few men they put on more, and more, until we found in most cities, the precincts were drained of men to handle our traffic problem to such an extent that we were laying ourselves open to appalling burglaries and other troubles in the outlying districts. In Buffalo, we have no more police on our force today than we had ten or fifteen years ago, and at the same time we have had to draw something like 150 men from the force to handle traffic in the downtown area, and quite a number more to handle school crossings throughout the city, during the day. All of them are withdrawn from the precincts and largely from the night shift. For instance, in one of our precincts which has seventeen posts, we formerly had seventeen men patroling, while now we are lucky if we get five at night. That is just an illustration of the effect of the traffic problem on general policing conditions.

As I said, the problem is an engineering problem, and the engineer has not gone into it as he should; but there is a very good reason. The engineer is not a politician by nature. His habit of mind is entirely different from the political habit of mind, and in order to do much with the problem he has to get into politics or at least he has to play the game according to political rules. So what we find is this, that where the engineer has come into the problem he has generally been brought in as a consultant, has been asked to make a survey and report, which he has done in good engineering style, has turned in a report of great volume, perhaps in a printed pamphlet, which being voluminous and requiring a large expenditure to carry out its recommendations, has been promptly put in a pigeon-hole, and we have gone right on just as we were. Now the engineer is really, in a case of that sort, a city planner; and I have no criticism to make of my brother city planners whatever. They are doing a fine job, but their aim is towards ten or fifteen or twenty-five years in the future, and what the police people need is help for the immediate present, tomorrow, today, and that is the part of the problem that the engineer so far has not generally tackled in a successful manner. There are a few cities—I know of three or four—where engineers have been brought into the picture in one way or another. Pittsburgh has a traffic engineer who is attached to the Mayor's Department. Detroit has one also. Both of them are young men, trained in the city planning field originally, but very active in the more immediate field of the things that have to be done from day to day. In Buffalo, I am acting as con-

sulting engineer to the Chief of Police under authority of the Mayor, and in Washington they have a commission which has a traffic engineer on it as an assistant. In those cities, we are beginning to bring the engineering viewpoint in contact with the daily problem, and we have made some little degree of progress. There are many other cities where, so far as I know, no progress at all has been made in that direction.

It may be presumptuous for me to come from a small city like Buffalo to tell you how to handle the problem of traffic in a big city like Philadelphia. Your problem is not exactly the same as ours by any manner of means because our city is still to a certain extent in swaddling clothes. We have not yet outgrown the habit of driving from our homes to our offices in our automobiles, leaving the automobile somewhere near the office, and perhaps using it once or twice during the day and driving home in it at night. The larger the city the less you can do that sort of thing, unless in the meantime you have developed particular facilities for that purpose. On the other hand, perhaps I can tell you something about traffic control in the smaller city from the very fact that it is smaller and therefore has had more opportunity to experiment.

In Buffalo we have had a very credulous council, in control for a number of years, and when traffic signalling first came on the map they bought every signal that was offered, regardless of its merit or anything else. They bought anywhere from one to ten, depending upon circumstances, which I won't go into, but at any rate we got at least one of every kind that was offered. That gave us a wide range of experience, and I am frank to say that on the basis of that experience we think now that our signalling is as nearly perfect as we can get it under the present state of the art. We have come to the definite conclusion that we do not want obstructive signals in our streets anywhere. We do want them suspended overhead where they can be easily seen, which means in the center of street intersections. We do not want an amber light to warn the standing automobile to jump out in the way of one that is just passing on the end of the green turn, so we only use red and green. We overlap the reds for a period of five to fifteen seconds, depending on circumstances to clear the corner. We find our motorists even then are jumping the signals, although not nearly to the extent that they did when the amber lights were used. We are shielding our signals so the red light can not be seen by the driver waiting on the cross streets. We have taken all of our blinkers out of the center of the street intersections and put them on the end of dead streets, or on curves, or dangerous points, in order to get them out of the way.

I do not think we have gotten anywhere near the end of signalling. Right now, signalling works pretty well when you have two thoroughfares heavily loaded with traffic. It sorts the traffic and gets it across the intersection safely in a very good way, but the great objection to it is that when you approach one of those signals in the middle of the night and there is no traffic in sight in any direction, it is a hardship just to be a good law observer, to sit there and wait for an interval of perhaps forty-five seconds, or a minute, for the signal to change, and, if you are not a good law observer, then and go across on your judgment, you naturally would be inclined to go across on your judgment at any other time of the day. Hence, at least three or four efforts are being made at the present time to develop such a signalling system that when there is light traffic on the streets, the signal will change at the approach of each car in either direction, and only when there is a dense enough traffic to make it worth while will the automatic timing system come into effect. That is easily possible from the electrical side, but difficult from the physical side, due to the fact that some means of connection is required between the automobile and the pavement, and when you have to deal with weather conditions such as we have in Buffalo, which means for five or six months in the year a snow, and a thaw and a freeze, you have a real physical problem to deal with that is difficult. Our street railway companies find that to be the case in keeping their switches clear, and a system of this sort such as I have indicated, would probably be equally or perhaps more difficult. I hope to see a development of that sort come from some Southern or Western city, such as Los Angeles, or Miami, or some place where they have no bad weather conditions. That will go a long way toward developing the signal toward ultimate perfection.

It is a curious fact that if you make

a spot map of the accidents, or the fatalities, that occur in a city, you will find that the fatalities particularly, and many of the accidents as well, do not occur at any point where you can control them. Last year we killed 116 people in Buffalo, and of those 116 people, upward of 80 were killed at points that could not possibly be put under police control. I mean by that, in residential streets, in the middle of blocks, places where nobody would think of trying to regulate the traffic. That means that something more than signalling, something more than police control, has to be accomplished. That something is the education of the public. That is not an engineering problem; that is a publicity problem, and I am not prepared to speak on it further than to point out the tremendous necessity for it. Again, when you make a spot map of accidents or fatalities, an apparently heavy accident occurrence is shown on main thoroughfares, but if against that, the traffic flow on the same street is plotted, the ratio between accidents and flow is lower on the busy streets than it is on the remote streets that are not busy. I haven't seen that worked out anywhere in a diagrammatic form, but I shall try it. I have studied certain particular streets enough to know that it is a fact. The same thing is true with regard to signals. Signal corners relatively do not produce as many accidents as unsignalled corners. A signal is not a device for moving traffic rapidly; it is for safety, primarily—you always get that complaint, that a signal slows up traffic. Of course it does. The only way to meet that is to provide a signal system such as they have on 16th Street in Washington, where signals are timed to meet the movement of traffic in a given direction at about its proper average rate, so that the signals change to meet the traffic, permitting it to go through without interruption. That is being done in a few cases—Chicago is the outstanding illustration today, for they have been using that system in the downtown area for a year with a considerable degree of success.

There are a lot of other aspects to the problem besides signalling, and the flow of traffic. The thing that impedes the flow of traffic more than anything else is parking. The business man comes day after day, and says, "This parking situation is terrible. The all day parker is the one that makes all the trouble." Well, maybe that is so; maybee it isn't. I don't believe it myself. I do not believe it for as a matter of fact in most cities today there are very few all day parkers. I don't believe it, more particularly, because we could not possibly accommodate with parking space enough people whose aggregate trade would pay even the ground rent of the stores. Counts which have been made in some cities show about 80 per cent of the patrons of a retail store arrive on foot and not by automobile. But it is hard to make the storekeeper believe that. The attitude of the average merchant is against a change, no matter what it may be. You can meet that to some extent by diplomacy, as we have done in one or two instances. For instance, a year ago we put through a regulation on our main retail street that there would be no parking, or standing vehicles, during the rush hour at night, 4:30 to 6. Anticipating a complaint from the retail men we took a count before the rule went into effect and noted how many automobiles were standing at each individual store during those hours, how many people got off and went in, and how many came out of the stores, got into the autos and went away. After the rule went into effect, the Secretary of the Retail Merchants' Association, on that street, came to police headquarters, to one of our Traffic Board meetings, prepared to make a tremendous objection. He said, "Why, my God, you've killed our business. There is no one stopping and coming into our stores between 4:30 and 6 any more." I said, "Do you know how many were doing it before the rule went into effect?" He had no idea. "Well," I said, "have you got figures with you as to what is happening now?" He had them. I said, "All right. I've got mine, too. Let's put them together." I lined my figures alongside his, and I had fewer calling and going away than he had. In other words, my records before the thing went into effect just by accident happened to be a little bit lower than his. It took the wind out of his sales to such a degree that he did not go into the meeting at all; he turned around and went home.

Now, about parking. The average business man says, "We've got to have some parking, but let's have limited parking. Let's limit it to an hour or to thirty minutes, or perhaps to fifteen minutes, in congested areas, and then we can get all the people in and out who want

to do business." Well, can you? Just to meet that situation, not long ago I made a survey of a particular block in our city, which was a typical block, a fair average of any city. On the circumference of that one block 52 autos could park, after making allowance for hydrants, safety zone limits and loading zones. Then, we determined the time on the average that an officer would take to put a tag on a car, and found that the average tagging time per car was two minutes. Supposing that the officer had to tag every car in the block, it would take him 104 minutes to go around the block, so you can see we could not even enforce an hour packing limit on that block. It so happened that they wanted a fifteen minute parking limit. Granting a fifteen minute parking limit, and that he only had to tag a quarter of the cars, he is still out of luck by quite a lot. But that isn't the worst of it. We have forty blocks in our congested area where they want time limits enforced. That would take forty policemen but we have to work them in two shifts, so that means eighty, and we've got—*two;* all that are available. Now, I ask you, what is the chance of a police department enforcing time limit rules even if you establish them? The real fact is, we put up the signs and then trust to the Lord that the people generally will observe them, or at least be afraid somebody is around spotting them, and so live up to them with some degree of care. But we are rapidly approaching the point where we will not allow any parking on our congested streets. We will limit them entirely to loading and unloading of either passengers or merchandise. That is an enforcible rule. A mounted officer can control at least four blocks of an ordinary street, where he has a no-parking restriction to enforce, but a footman can not enforce a single block on time limits. The day is rapidly coming too when most enterprises, mercantile, amusement, or what not, that involve the drawing together of large masses of people, many of whom want to come in their own machines, will have to necessarily provide off-street parking space to accommodate those people. We are getting to that in Buffalo right now. Some of our retail stores either have garages of their own to which they drive the cars of their customers with their own men, subject to call, to bring them back when wanted, or they have working arrangements with nearby garages by which they absorb the parking charges. Further, we are now heading towards double decking one of our markets, near the business area, with the idea of taking the marketing cars off the street during the daytime and the amusement cars off during the night. That is a real answer to the problem as far as parking is concerned.

EXPERT ENGINEERING TESTIMONY

By Frank Nevins, of Keelogg and Rose, Attorneys, New York, N. Y.

(From Proceedings of American Society of Civil Engineers for March, 1927.)

You have asked me to boil down to as brief a space as possible some parts of my little talk before the American Institute of Consulting Engineers recently on the subject of expert testimony. If some of the gentlemen present were kind enough, as you have said, to call my talk "getting down to brass tacks" on the subject I am glad that it appealed to them in that way, because that is what I was attempting to do. My discussion was less one of theory and ideals of expert testimony which had already been covered in a most thorough and masterly manner by Judge Hough of the United States Circuit Court of Appeals and former Attorney-General Wickersham, and more an attempt to make a few practical suggestions which might render expert testimony more effective and convincing under the rules and standards which now govern it.

Qualifications of Witness

It is my feeling that it is of the greatest importance, particularly in regard to engineering expert testimony, that the engineer presented as an expert shall state carefully and concisely and without unnecessary veriage, his qualifications and experience which entitle him to testify as an expert. Such statement of his qualifications and experience must necessarily have very great bearing on the weight which the jury or court will give to his testimony. It is not always easy for counsel to bring out fully qualifications and experience of an expert, because in an apparent spirit of frankness and desire to save time the opposing counsel will frequently say: "We concede the qualifications of Mr. So and So." That concession, to my mind,

the court should be asked to and should disregard, for the reason that very frequently the concession is neither frank nor for the purpose of saving time, but for the purpose of minimizing the weight to be given to the testimony of the expert. The weight of the testimony of an expert will very largely depend on qualifications and experience, and if they are not stated, then much of the weight of the testimony is lost.

Judge Hough deprecated the experts assuming the attitude of an advocate and said that he felt that such a stand by the expert prejudices the jury and court unfavorably. His point, as I understood it, was that over-zealousness of experts going to the length of advocacy would tend to impress the court and jury that the expert was trying to maintain his point at all costs without sufficient regard for the reasoning or principles of science upon which such testimony was based. I make only one exception to Judge Hough's statement, and that is that where the expert witness has stated an opinion based on careful study of the case as a whole and pertinent to the hypothetical question or questions which may have been asked of him, that it is the duty of that witness, but without undue zeal, to state all the reasons, all the factors, all the elements, that caused him to form that opinion and in every proper way to defend his stated opinion to the same extent, by way of illustration, that a judge does in supporting his decision of a case by carefully reasoned, logical opinion which sets forth the reasons for such conclusion.

Simple Language

That statement necessarily led to my next point, which was that the expert should state the factors, the elements, and the reasons underlying his opinions as given in clear, concise, simple language with a minimum of technical terms and expressions in order that the jury might understand the reasoning and principles on which the opinion was based. Engineering expert testimony is quite different from the broad general range of expert testimony. Engineering expert testimony is very largely based on principles and laws of engineering, an exact science. It is possible for the engineering expert to make the court and jury understand the reasons for the opinion which is expressed, and the weight of engineering expert testimony will be very materially increased if the opinion and the underlying reasoning are given, not in the form of dogmatic statements, but with an explanation made as clearly and simply as possible and in words and terms understandable by the layman, as to why the expert holds and states his opinion.

What I last stated was directly in line with what Mr. Wickersham said in pointing out, as he did, that the theory of expert testimony was the elucidation and explanation for the benefit of the court and jury of matters technical and beyond the understanding of the ordinary layman.

In any case involving engineering expert testimony, the engineer who is to testify should never be satisfied with simply considering those facts which council may present to him in the form of an hypothetical question, but should insist on being informed of all of the facts which the litigant whom he appears for concedes as existing in the case in order to be sure that the opinion stated shall be one that will not only be a fair and proper answer to the facts of the hypothetical question, but shall be consistent with all of the facts which the side of the controversy that he is on concedes and admits. If the engineering expert does so guard himself by having knowledge of all such conceded facts, then having determined that his opinion on the hypothetical question is correct in view of all the facts, he can testify with confidence to his opinions knowing that they are sound, fair, in accordance and consistent with all of the facts in the case, and that he will be in a position to honestly and conscientiously defend those stated opinions in the face of all or any other facts that may be presented for his consideration on cross-examination. In that respect and to that extent under such circumstances, of course, the engineering expert is an advocate. Knowing of all the facts in the case and knowing that his opinions are sound, formed on and consistent with the entire range of facts, he should in an unprejudiced and impartial way defend them and stand ready to demonstrate their accuracy and correctness.

Personal Knowledge

If I may be permitted to trespass on the allotted space a little further, I would add two thoughts for the guidance of the engineering expert: Be sure that your honest conviction is that on the

engineering features of the case on which you are called to testify, the opinion which you express is sound and in accord with both your theoretical and empirical knowledge of the subject. Insist on knowing from personal observation of the matter which is involved in the case in which you are to testify as much as it is possible for you to know of the facts, for the more that the engineering expert knows from personal observation the more convincing will be his evidence on matters of opinion.

In my talk the other night I approached and now approach the subject accepting as a fact that we have with us difficulties and troubles with the giving of expert testimony. I am well aware that some modification or change of the scheme of expert testimony might be advisable, but until that time comes and that is done, we should do what we can to secure the best results from the giving of expert testimony as we are now limited in presenting it before courts and juries under existing rules and standards.

PROJECTED LOS ANGELES TO COLORADO RIVER AQUEDUCT

By William Mulholland, Chief Engineer and General Manager, Bureau of Water Works and Supply, Los Angeles, California.

(Presented before California Section of American Water Works Association, October, 1926.)

Before proceeding with the subject of the Colorado River, it is proper that we should show some reason for the venture. For that reason I wish to advert a little to the present condition of the city of Los Angeles and to the motive that impels her to look so far distant so soon after the great adventure of some twenty years ago, to-wit: the building of the Los Angeles Aqueduct. I was the sponsor of that project as I am of this one. Being responsible for this project and considering the necessity of the occasion as at the end of the drouth following the years 1902-3, we were at our wits end for a water supply in the city of Los Angeles and there was an impending shortage. If the drouth had lasted another year or two that would have ended the city of Los Angeles. We were afraid of that, but a normal rainfall came and we got along for another ten years or so by reason of the fact that there was a restoration of the normal precipitation. We are now, I hope, near the end of another, a very disastrous and long continued period of drouth. We all know—all of you who study the water supply of this district, that we are on tenterhooks as to where the next year's supply is coming from, or the year after that, and you all know that we have had a drouth of very drastic and fierce persistence up and down this State. The ground waters have receded; the streams have dried up; the lakes have dried up and all of the rest of the things have happened until the water situation leaves us on the verge, not of total destruction, but of great distress. If we do not get a rainfall within a year or two this city will suffer a knockout blow for many years that will suppress and check many useful projects for the public weal in this State.

This matter was presented to the city of Los Angeles as it was to the city of San Diego and every other city up and down the coast from San Francisco—even from the Siskiyou clear to San Diego and even further north.

To my great surprise the cities of Portland and Seattle are also complaining, not on account of any insufficiency of the water supply which is within striking distance of those cities, but the storage facilities for their respective water supplies were not adequate to meet the conditions of drouth that have presented themselves within the last few years. We have to be forehanded. Of all other professions in the world, the man with the responsibility of supplying a city with water has to be forehanded. He must look ahead and look a long way ahead, discounting every possible sort of condition that may arise. You can not get up in my position—and many of you know the position I am in here—you can not get up and make excuses to your employer, your public. You must guess your crowd, plunge, go ahead and for their welfare provide an adequate water supply. It is all right if they reject your proposals. You are excused. But if you do not present the matter in a positive way to the people and some disaster occurs, you are at fault and you can not evade the responsibility.

The people of the city of Los Angeles are not acquainted with the dis-

aster that impends by reason of her prosperity. Prosperity is not always good, it gets people off the alert and they disregard a proper sense of security.

The major part of the city of Los Angeles is located south of the Santa Monica Mountains. There are frequent checks made from time to time to determine the tendency of the city's expansion. The people in the city of Los Angeles have not induced that tendency. It is the people lying outside of the city of Los Angeles that want to pull the blanket over their feet to obtain a share of the water supply. There is scarcely a month passes that we are not appealed to by people around the rim, much to our resistance—for what?—to get a share of the city's water supply. Now we have had to extend and extend until at the present time the area of the city of Los Angeles is 430 square miles. That is the size of the city we have to supply and you will all appreciate the fact that it does not make for a cheap water supply or water works.

The population, as determined by many observations, at the present time is more than 1,200,000. The population of the city per square mile is 2,700. Imagine a diffused population like that spread over such an area. To provide a city of that size with water requires 2,800 miles of main pipes; more than one-tenth of the distance around the world. The mileage of main pipes in the city has been doubled within the last five years. The number of services is 240,000. The domestic water consumption of the city in summer is 152,000,000 gal.; in winter, 123,000,000 and a mean of 138,000,000 gal. per day.

I recall when I first did some work for the northern cities, the consumption of water in the city of Oakland was about 16,000,000 or 17,000,000 gal. per day, the consumption in San Francisco was close to 40,000,000 gal. per day. I do not know, however, what the consumption of those cities is today, but possibly double what it was at that time. Compare that with the city of Los Angeles, with 138,000,000 gal. per day.

The city of Los Angeles is virtually on the edge of a desert. You may go in any direction from the city, north, south, east or west and you will find the desert before you go very far—the arid, grinning desert.

The city of Los Angeles had to go 250 miles to the north, over three mountain ranges, and across deserts and waste plains to the Owens River to get her last water supply. Why has she outgrown this supply so rapidly? The very fact itself that she got it, attracted the people to our city. It added tremendous prosperity and attractiveness and brought people here.

I recollect when I was campaigning for the bonds for that water supply, people would ask, "How long will that last you?" I believed fully in the growth of the city, but never felt it would reach its present proportions in such a short span of years. I am, and always was, the greatest pessimist on the question of the growth of the city of Los Angeles and I hope she stops tomorrow. But she grows in spite of me. Yet people would ask me, "How long would that last?" and I would say, "It will last until she grows—until we have a population of one million people; as soon as we get a million people we will have to seek another water supply."

We now have a million and one-quarter population and we are still living on the old water supply with the population still increasing as rapidly as ever and very naturally I am still in the same nightmarish state of mind as I was 30 years ago.

We pump water in the city of Los Angeles. The criticism offered to the proposed aqueduct from the Colorado River to Los Angeles, is that we will not be able to pay the cost of pumping this water by the time we get it to Los Angeles. We know what it costs to pump water. Our pumped water at the present time is 80,000,000 gals. per day. That is more than San Francisco and Oakland use, yet we pump that quantity. You can not scare us with pumping water, if we can get water with no very great taxation but that of pumping.

In addition to that, the Colorado River carries with it the proposition of power development. There is tremendous power to be developed and I will say that we propose to develop it. A quantity of 1,500 second feet of water will require just about one-third of the power that can be developed at the Boulder Canyon Dam. You can not put power to better use insofar as Los Angeles is concerned or insofar as California anywhere is concerned, than to pumping water for profitable use.

We can pump the water there if we get the power at cost plus cost of operation, say for 5 cts. per 100 cu. ft., as we are selling water today in Los Angeles for 13 cts. per 100 cu. ft. So it will be seen that there is a good margin before we reach the limit of 20 cts. per 100 cu. ft. The cities of Oakland and San Frascisco charge 25 or 28 cts. per 100 cu. ft. and I claim right now that that is cheap water. Why should a man get water, the essential element of life, more cheaply than the cost to him of polishing his shoes or paying for his telephone? The telephone rates in Los Angeles are far in excess of the rates for water. They should not be. We can stand to pay far more than we do at the present time for water. I am not protesting against the existing rates for water in the city of San Francisco or Oakland as I have always found that the rates are perfectly justified. The people who brought the water there and entered the field of supplying those two great cities with it were justified in making the rates which they did. The rates which they made were approved by the State Railroad Commission.

If we can get water into the city of Los Angeles, through an aqueduct, from the Colorado River, for 20 cts. per 100 cu. ft., and I am certain that we can, we shall still have a cheaper water than the average large city in the United States. Remember, other large cities that front on rivers or lakes have never had to worry about their water supply. The city of New York had the greatest problem and yet she never went more than 120 miles and there were no mountains to climb. It all came by gravity. She is the only city that had any great water problem; the others just dipped their suction pipes into the rivers or lakes.

You gentlemen are required to contemplate in your every day business, greater problems than any city in the east; you have a more extensive job before you.

The city of Los Angeles is peculiarly situated; the great area to the north of it; the San Fernando Valley is being very rapidly settled; it was used as the dumping ground for the Owens River water pending its need for domestic use, and was used there temporarily until we should know what to do with it.

Our storage facilities for this supply in the San Fernando Valley were too far removed from the city proper for safety, and provision was made for additional storage closer to the city, on the margin of the Santa Monica Mountains, where we now have a storage free from any risk of interruptions. These reservoirs are very capacious, having an average capacity of 30,000 acre feet with supply mains running right into the city.

The insurance companies used to wonder how we were going to safeguard our water supply. There is not a city in America whose water supply is so completely safeguarded against interruptions. Why? Because it was built with that end in view. We have thirteen mains leading into the city and do not depend upon any one main carrying water from a remote source of supply. I am not taking any particular credit; however, my organization is to be thanked for it. The thing seemed to be suggested naturally and it was so built. I think it is the Bible or the Koran or other high religious authority that said: "He who bloweth not his own bazzoon the same shall not be blown."

The new project embraces the territory lying between the Colorado River and the Pacific Ocean southerly of the Boulder Canyon Dam site. The ostensible first route was surveyed for the aqueduct to convey water from the Colorado River. Since we started on the surveys for this route we resolved not alone to survey that line but the potentialities and possibilities of other directions to get a cheaper line. We started broadcasting and within certain boundaries, including the entire Boulder Dam Country clear over to the Grand Canyon of the Colorado, we closely surveyed every bit of the area and it will be shown in our complete topographical map. This entire country is worked out into a model relief map so that we can stand in front of that map and plot any route without leaving our office. Every bit of it has been traced mile by mile. We found out where tunnels and siphons will have to be built and where the ground is too high or too low. It is the most monumental piece of work of its kind ever constructed and is within a month of being completed.

The direct route from Blythe to Los Angeles is the one that requires the least tunnelling; it is the one that comes out with the higher point of delivery. I will not deny the fact that I am in favor of that route. I do not like to boast

about the discovery, but if you turn a jack-rabbit loose at the Colorado River and head it for Los Angeles, and scare him enough, he would go via that route.

The governor of this state, shortly before election, announced that he and his engineers had discovered a shorter route for the Colorado River Aqueduct. I do not know how he found it up there in his office at Sacramento. Neither have I been able to verify such statement from his engineers. On the contrary these gentlemen whom I know well, spent ten or twelve days with me all over that desert country and have informed me that they made no such claims.

We can take our map and draw a line along any route that may be proposed by a normal person, as a substitute for the route we have. We did that to guide the people in their judgment and estimation of our ability to lay out the line. If they can find any way that this line can be shortened, decreased in cost, or increased in efficiency, we are willing to let them do it that way and the map will be before them.

I think it is a great thing that the city of Los Angeles has not been discouraged by the shortage of the Owens River Aqueduct supply (due to the prolonged drouth affecting the entire coast area), but have turned to this new project.

The Los Angeles Aqueduct cost us a bond issue of $153 per capita. We had at that time 160,000 people in the city of Los Angeles. Now that did not scare the people. They went to the bat and built the aqueduct receiving their benefit in the shape of billions of dollars in increased value to the real property alone, which paid for the aqueduct many times over. That debt is a little over one-third paid off at this time and we are going to undertake another debt. The estimated cost, in the rough, is between $150,000,000 and $200,000,000. It will not cost as much per capita as the Owens River Aqueduct. The city is proportionately larger than it was then so it is therefore not a great undertaking.

I reasoned these things out—soothed myself. I am itchy about it. I am afraid to talk about that much money as I was brought up by frugal people in Ireland and there was not that much money in all Ireland I am sure. At any rate, it will be about that sum and I do not think the people need fear to incur the debt, nor do I believe the people will have any such fears.

The people of Los Angeles are a canny kind of folk but where they can see a profit they are going to invest—you can depend upon that.

San Francisco is a city for which I have always had great admiration in every way. She has been burned up; shaken up; and the people turned to and rebuilt her within a couple of years and then turned around and staged a fair the equal of anything in the world. But there is something about her not the same as Los Angeles. She is not a practical city; the people cavil and do not get together on material things. They undertook the Hetch-Hetchy—there is something providential about the city of San Francisco—there is something that seems to look after her. She has never suffered a water famine and some of us who know about the water works condition of that city, marvel how the water works men of that city can go to bed nights and sleep; they have been on the verge of disaster for several years. They have a wonderful project in San Francisco, the Hetch-Hetchy. I have often wondered why they do not call it the Itch-Itchy, because they have been scratching themselves about it for 30 years. As a matter of fact they began work on it ten years before Los Angeles undertook the construction of the Owens River Aqueduct. They can remedy that; they are proud, fine people and many of them who hear my remarks tonight will no doubt write me very indignant letters, but I am telling you what is the truth, that the people of the city of Los Angeles are not than kind. They do not compare in many ways in romanticism or chivalry with the people of San Francisco, but they can get together and do a job of work,—just authorize them to do it.

GRAVEL INSPECTION METHODS USED IN MICHIGAN

By R. L. Morrison, Director, Michigan State Highway Laboratory, Ann Arbor, Mich.

(Paper presented at Eleventh Annual Convention of National Sand and Gravel Association.)

Some years ago the general idea seemed to be that all contractors and material men were constantly looking for, and taking advantage of, opportu-

nities to "put something over" on the engineers, and that the main function of the inspector was to act as a spy, or watch-dog, to detect and prevent such attempts. This attitude on the part of the inspector naturally made the party of the second part feel that he might as well "have the game as the name" and each job was apt to be a lively contest between the inspector and the foreman to see which one could tag the other oftenest. As a rule the foreman considered most of the specification provisions as pure "tommy-rot" and his ignorance of what was needed was only exceeded by that of the inspector, whose qualifications for his position were too often about 99 per cent political and a small one per cent technical. The gravel inspector usually believed that he must reject a certain number of cars each day in order to hold his job and the particular cars to be rejected were often chosen by the "eenie meenie miney mo" method.

Fortunately those days have passed into history. Today the engineer recognizes the producer as a man whose ethical standards are just as high as his own, the producer's problems are better understood, and a sincere effort is being made to secure the desired results with the least possible interference with production. On the other hand the producer is studying the engineer's problems and is constantly devising methods for the improvement of his products along sound engineering lines.

The function of a laboratory engaged in the inspection of sand and gravel is threefold. First, it should see that the materials supplied to the work comply with the specifications. Second, it should conduct research investigations to aid in determining just what properties the sand and gravel should be required to have for a given purpose, and what customary specification requirements can, or should, be modified, if there are any such. Third, it should assist the engineer with advice in specifying and using the materials under various conditions and it should assist the producer with advice, when requested, as to possible methods of improving the product so that it will comply with the specifications, if difficulties occur.

Before taking up the matter of inspection methods, it may be well to say a word about specifications. The beginner, when he first comes in contact with construction work, in any capacity, is apt to feel that specifications are something almost sacred, the product of an infallible wisdom. It would seem that too often this attitude is never outgrown, for few investigators have had a sufficiently Missourian complex to determine the exact effect of varying different properties beyond the customary specification limits. Unfortunately, when they have attempted to do so, the doctors have not always agreed, as witness the violent controversies as to the proper method of grading concrete aggregates.

Our present specifications are based partly upon sound deductions drawn from long experience, partly upon accurate scientific investigations, and partly upon opinion and tradition. The last named class of provisions is being subjected more and more to the fire of experience and research and it is probable that within a few years specifications for sand and gravel will be based entirely upon known facts. Sometimes the supposedly known fact of today becomes an exploded theory tomorrow, but at least knowledge is crowding out unsupported opinion and tradition, and will continue to do so.

The reasons for the various provisions of our specifications are about as well known to modern producers as they are to engineers, and a detailed discussion of them would take entirely too long. It will suffice to say that while the specifications are admittedly imperfect, they are based upon the best information available at present. Changes will be made as our knowledge increases, and every effort should be made to add to our knowledge, but in the meantime it should be remembered that these specifications have been developed through years of experience, and have given the best results which have been obtained to date.

The organization of the sand and gravel division of the Michigan State Highway Laboratory consists of an aggregate laboratory at Ann Arbor and a corps of plant inspectors in charge of a chief inspector.

When the laboratory is notified that a plant is shipping as much as ten cars daily to a state highway project, an inspector is sent to the plant. Before a new man is sent out as plant inspector, he is drilled for at least a week in the Ann Arbor Laboratory in the testing of aggregates, and if possible is taken to nearby plants to observe their operation,

or he may serve for a short time as an assistant inspector under a more experienced man.

When he receives an assignment, the new man, together with his equipment, is taken to the plant by the chief inspector.

Upon arrival at the plant the equipment is first checked and set up by the new man, and he is instructed in its use under the handicaps of location outside the laboratory. The standard equipment consists of the necessary screens and sieves, 2,000-gram capacity scales, 200 c. c. glass graduates, a supply of sodium hydroxide and bottles for organic matter tests, a trowel, counter brush, drying pans, large spoons, sample sacks and stationery. A small oil stove is required if there are no facilities at the plant for drying aggregates.

After the equipment has been arranged, the pit is visited and the chief inspector points out possible sources of trouble, such as excesive overburden not removed, clay pockets in the bank, parts of the bank containing an excess of fine material, old stumps, possible oily shale ledges, or other sources of organic matter. This study of the pit puts the inspector on guard against the particular difficulties which may arise from that quarter. From the pit the inspector is taken to the top of the screening plant. As a rule he can get a bird's eye view from there of the entire layout of the pits, tracks, waste piles, etc., which gives him a clear idea of the general system of operation.

Next the material is followed down through the plant and the screening and washing methods are studied. Such items as possible overloading of screens, insufficient water supply, etc., are noted. Special attention is paid to the arrangements for combining sizes and loading cars. The attention of the new inspector is called particularly to points where segregation may occur.

After this examination of the plant a conference is held with the plant superintendent and suggestions are made as to possible methods of eliminating sources of trouble. For instance, arrangements may be made for additional stripping work to reduce the amount of clay going through the plant, the steam shovel may be moved to another part of the pit, the rate of feeding the screens may be reduced, more water may be used in washing, or washing may be done at additional points, arrangements for combining sizes may be improved, baffle plates or other devices may be installed for reducing segregation in loading cars, and one or more men may be put to hand-picking soft stone from conveyor belts. By such methods the quality of the product can often be greatly improved with very small expense to the producer.

The new inspector is then ready to begin work and he is first taught how to sample cars. This is one of the most difficult operations in the whole field of highway materials inspection, and a carelessly taken sample may not come anywhere near to representing the actual average contents of the car. Incidentally, it seems rather like wasted energy to argue over fine-haired differences in screen sizes until the general methods of sampling and handling materials can be so rigidly specified that reasonably consistent results can be obtained on different samples taken from a single car of gravel at different times.

The method used by our laboratory in sampling cars is to dig "shoulders" on about six or seven of the "waves" formed by the movement of the car in loading. About three of these shoulders are usually dug in the center of the waves and the other four about half way between the center line and the side of the car, half of them being located on each side of the center line. Samples are then taken by digging into each shoulder, and these samples are placed upon a sheet of metal. After thorough mixing, the combined sample is quartered, if necessary, to get a single sample of the proper size. Some additional digging should be done to detect the possible presence of sand cores at some distance below the surface.

After learning how to sample the cars properly, the new inspector is given additional instructions in making tests under plant conditions, in making reports, etc. Usually the chief inspector remains at the plant for a day or two until everything is running smoothly, and then he makes frequent visits to it during the construction season.

The routine inspection consists of doing from day to day more or less of the work which has been outlined above, the exact routine depending upon varying conditions at the different plants. As a result of his tests, the inspector soon becomes sufficiently familiar with the aggregates being produced so that he can make a fairly accurate estimate of the

grading by watching the loading of the cars. Whenever it is possible to do so, he samples about a third of the cars, and then tests the samples at such times as the plant is not loading cars for state work. It is evident that the majority of the cars must be passed or rejected on the basis of visual inspection only. This is not complete inspection, so that additional examination, and possibly rejection, at the job does not constitute double inspection. This matter will be referred to later.

Once each week the inspector tests a sample each of fine and coarse aggregate and then sends the samples in to the laboratory, together with the results of his tests. Check tests are made there and if there is any appreciable variation in results the inspector's testing methods are checked up.

One of the greatest difficulties with which the inspector has to contend is the formation of sand cores due to segregation in loading. The fine material often drops immediately to the bottom of the car and remains in place, while the coarse material rolls to the side. As these sand cores are at the bottom, it is difficult to detect them after the car is loaded. Every effort is made to watch for their formation and to eliminate them by correcting improper loading methods, and the installation of anti-segregation devices, but in spite of all efforts they will sometimes "get by" the plant inspector without being detected.

When the volume of shipments to state highway projects is not sufficient to justify placing an inspector at the plant, the inspection is handled on the job, usually by the project engineer. He is furnished with necessary equipment and also sends occasional samples to the laboratory.

It is sometimes necessary for the engineers to reject aggregates on the job which have been passed by the plant inspectors. This practice is sometimes referred to by contractors and aggregate producers as "double inspection" and, in the past, has been strenuously objected to by them. Such objections to so-called "double inspection" are, however, based upon a misunderstanding of the situation.

In the first place, the specifications form a part of the agreement with the contractor and cover the materials at the time that they are placed in the mixer. It would be entirely logical under the contract to have all inspection performed on the job, even right at the mixer skip, all unsatisfactory material being rejected at the last moment only. This, however, would involve a great expense in freight and handling charges on rejected material and frequent annoying delays to the work. To reduce such expense and delays to a minimum, the state places the inspectors at the plants to stop unsatisfactory aggregates at the source. In other words, the inspection is essentially at the job, but a man is put at the plant to keep poor material off the job so far as he is able to do so.

As a matter of fact, there is very little material which has to be rejected on the job after it passes the plant inspector, but it is extremely doubtful if plant inspection of aggregates can ever be made 100 per cent perfect. In the case of such materials as cement and steel, samples can be taken in a specified manner from each car and every sample can be tested, so that when a car is once approved there is no reason for subsequent rejection, except possible deterioration from some cause after shipment.

Unfortunately, however, aggregates are not susceptible to such exact plant inspection methods. As an extreme case, there is one plant which has a capacity of about 200 cars daily. This would be an average of a car every seven minutes during a 23-hour day, if shipments were at a uniform rate, and with a much smaller daily output, the rate of loading may be as fast, or even considerably faster, for a few hours a day. As it takes at least ten minutes to sample a car properly, and about an hour to make a complete test of a sample, it is absurd under such conditions to say that an inspector's card on a car should be considered as a guarantee of quality and that all further inspection should be eliminated. What actually happens is that one inspector watches the car as it is filled, and if it looks all right he signals another inspector, who tacks on the card. Five minutes later the car may be half a mile down the track and thirty minutes later it may be on the main line headed for the job. In some other cases, aggregates are loaded and shipped at night, which of course makes plant inspection still more difficult.

The above discussion should dispose of the "double inspection" bogey, and demonstrate the necessity of inspection

on the job, even where the cars bear plant inspectors' cards.

Most of the research work of the Michigan laboratory consists of carefully planned and rather extensive investigations, but short investigations are sometimes made to assist in arriving at a fair and proper decision upon some special point.

As an example of the latter type, a question arose some time ago in connection with routine inspection. We had been permitting a maximum of three per cent of certain conglomerate material. This limit was purely arbitrary, but it was believed to be safe so far as the work was concerned, and did not cause any rejections at the plants. Suddenly, on a Saturday morning, the steam shovels at one of the plants ran into a bank which contained about twice as much as the allowed percentage of this material, and the work was shut down by the inspector. Another representative of the laboratory drove to the plant from Ann Arbor and obtained a supply of the questionable material. When he returned Saturday night, several members of the staff worked until midnight making up lumnite cement cylinders, using varying percentages of the conglomerate. The cylinders were broken Monday morning, and as a result of these tests, the limit was raised sufficiently so that loading was resumed immediately, with no rejections made.

An example of more detailed research work was an investigation of the effect of soft stone in concrete. Compression cylinders, beams, and Talbot-Jones wear blocks were made and tested at various ages. As a result of these tests the limit on such material was raised sufficiently to permit the use of one large deposit which would have been rejected entirely under the former ruling, and it might have been necessary to abandon the plant, as the entire output was being furnished to the state.

In both of the above cases the investigations resulted in large savings to the producers after the tests had definitely indicated that a modification of the specifications would not do any injury to the work.

The exact effect of other presumably deleterious particles in gravel is being studied, and when the investigations have been completed the results will be published.

When samples of aggregate are submitted by engineers in the field the laboratory does not make positive acceptances or rejections, but always makes a recommendation. The reason for this is that in borderline cases full knowledge of all local conditions is necessary for a proper decision and the laboratory seldom has such detailed information. The recommendation, however, is almost always followed.

Our inspectors are instructed never to interfere with the operation of a plant or to give advice to producers unless they are sure that it is desired, but we are always glad to make suggestions when they are desired, and the majority of the plants in Michigan have made various improvements at the suggestion of the laboratory.

I can not speak too highly of the cooperation which we have received from the gravel producers. They have assisted us in every possible way, and during the two years that the plant inspection of gravel has been in charge of the laboratory, there has not been a single controversy which has not been amicably settled to the satisfaction of all concerned.

"AN ENGINEER FOR PRESIDENT"

The following resolution was passed at a recent meeting of the Board of Directors of the American Association of Engineers:

Whereas, much of the present high standard of living in this country has been accomplished through the practical application, by engineers, of scientific and engineering principles to industry; and

Whereas, the more recent application of these principles to our federal government has resulted in a remarkable co-ordination of industry and government, to the great benefit of every citizen; and

Whereas, future development of industry and increased prosperity of the nation are dependent upon an extension of these principles and co-ordination, which can best be attained by the placing of chief executive authority in the hands of an engineer;

Now Therefore be it Resolved, that the American Association of Engineers, through its Board of Directors in meeting assembled at Chicago do hereby endorse the elevation of an engineer to the Presidency of these United States.

RECOMMENDED FLOOD CONTROL MEASURES FOR THE MISSISSIPPI VALLEY

By Edgar A. Rossiter President of the National Drainage Congress, Civil Engineer, 160 N. La Salle St., Chicago, Ill.

When New Orleans was settled by the French, the natural surface of the ground was but a few feet above the level of the Mississippi River. The low water level of the river is now some eighteen to twenty feet above the level of the city streets. In fact, the river is some eighteen feet above the level of Lake Pont Chartrain and the Gulf, due to the constant filling in of the silt at the mouth of the river.

Some Engineers have a hobby of dykes or levees and they will build them and keep on raising them contrary to all hydraulic laws of flood control or the movement of silts. These levee enthusiasts have kept on constructing them, with the idea that the next generation will have plenty of time to study the silting question, but the time has arrived for action, or New Orleans will pay the price during the next flood.

Drainage Engineers have long ago discovered the danger of building levees without the proper consideration of silting.

As a result of the construction of these levees, the flood waters in each cycle have become more and more dangerous, and unless some definite and drastic method is adopted to eliminate this evil, the loss of property and of life will be far more appalling than we have yet experienced. I have no fear in predicting that the present flood, with its losses running into millions, is but a patch to what the next flood will be. This being due to the millions of cubic yards of silt that have been washed down the greater streams of the Mississippi Valley.

When a stream in its natural condition overflows its banks during flood times, the greater part of the silt precipitates over the flooded area due to the lesser velocity there than in mid stream and after the flood has passed a deposit ranging from ½ in. to 9 ins. is often found over the entire bottom lands. But where flood waters are confined to certain lines within levees, the silting is more uniform, except in narrow channels where a greater velocity is maintained. Where the stream widens out great bars of silt are formed by reason of the lesser velocity.

Systems of levees should be so designed that where there is a great area of low lands, the levees should be constructed far apart, thus forming silting basins from which the silt could be removed and spread over the adjoining low lands. This has never been done due to the fact that our laws are such that the burden of the cost must be borne by the owners of the low lands.

We are now confronted by the problem of either cleaning out the silt or building the levees higher, and there is an economical limit to the height of a levee several thousand miles long, when you consider that the average silting amounts to 3 to 10 ins. per year. A study of silting since 1908 discloses the fact that streams will silt as much as *nine feet in eleven years.*

If all the Contractors in the Country were put to work raising levees on the Illinois, Mississippi and other rivers, they could not raise them sufficiently to get ready for the next flood.

The proper solution now is a comprehensive plan to clean out and straighten the river channels from the Delta so that the river may once more flow down in its natural channel. Then plan for silting basins, reservoirs and flood control along each tributary where possible, and then maintain the same annually instead of paying millions per year in loss of life and property.

Building several thousand miles of levees 5 ft. higher, will soon be a regular annual event, while the cutting of an adequate new channel through the Delta, lowering the water table 19 ft. or more will be a much more reasonable and sensible undertaking, and keeping it free from debris and silt will be a comparatively small expense, when one considers the cost of raising the levees.

TREND OF PRACTICE IN WATER PURIFICATION

By Paul Hansen, of Pearse, Greeley & Hansen Hydraulic and Sanitary Engineers, Chicago, Ill.

(Paper read at annual meeting of Canadian Section of American Water Works Association.)

It seems to me that the outstanding development and event in connection with water purification in recent years has been the acceptance of a standard of purified water. That standard is

what is known as the United States Treasury standard. It demands now, according to the latest revision of that standard, not more than one B. coli per 100 c.c. in the purified water. That has done more than any one thing to chrystallize and define water-purification practice.

Degree of "Permissible" Pollution.

Another thing it has done, and one which you will hear a great deal more of in the future, is that it has enabled us to secure a knowledge of the degree of pollution that is permissible in raw water. The first expression of that degree of polution was given by a committee of experts called in by the International Joint Commission on boundary waters. On the basis of statistical evidence, they expressed the opinion that raw water should not contain more than 500 B. Coli in 100 c.c. Water more polluted than that was too polluted to be purified. Later on there was an investigation by Streeter, of the United States Public Health Service, who made a statistical study of some twenty-five water-purification plants, involving filtration and sterilization, in the central west. These statistics were presented to the Journal of the American Water Works Association, and showed that there was a definite relation between the quality of raw water and the quality of filtered water, and indicated that the pollution of the raw water should not exceed 650 B. Coli in 100 c.c.

Streeter pursued his studies further by making an extensive study of some ten water-purification plants on the Ohio River, and by building an experimental water-purification plant at Cincinnati. These further studies indicated that filtration alone could not handle water successfully and produce an effluent equal in quality to the Government or "United States Treasury" standard. With liquid-chlorine sterlization following filtration, it was possible to successfully purify water with a B. Coli bacilli content of from 5,000 to 6,000 in 100 c.c.

Where plants were elaborated to include double coagulation and double sedimentation, filtration and sterilization, it was possible to handle raw water containing about 10,000, or possibly more, B. Coli bacilli in 100 c.c. And if we would still further elaborate the process so as to include secondary filtration, possibly of the slow-sand type, and so on, we might be able to handle water containing as high as 50,000 B. Coli.

Coordination Between Water Purification and Sewage Treatment.

Now all this raises the interesting question of how far we are going to go in permitting the use of polluted water and how far we will have to go in the elaboration of our water-purification plants to meet that pollution. Also what are we going to do about limiting the pollution of streams by requiring municipalities to put in sewage-treatment plants? In other words, the time has come when many of the streams, both in the United States and Canada, are being polluted to such a degree that we have got to consider co-ordination between sewage treatment and water purification.

Just what that co-ordination will be, is something that will have to be given a great deal more thought and study. At the present time, there is no chrystallization of opinion on this subject. The general impression seems to be that we cannot go on indefinitely elaborating water-purification processes, and that there comes a time when the aesthetic sense of the community rebels against pollution in raw water.

Another matter that we have to consider is how efficient purification plants may be in removing that pollution.

At Albany, N. Y., water pollution became so great that they had to elaborate their purification to include preliminary chlorination, coagulation, sedimentation, rapid sand filtration, slow sand filtration, and finally sterilization. Even though they were able to produce safe water, public sentiment has condemned the system, and has demanded expensive measures to lessen the pollution.

It is generally difficult to co-ordinate sewage treatment and water purification, because there is no adequate central control governing the two things. Usually the municipality upstream polutes the water supply of the community downstream. They are usually not disposed to put in sewage-treatment works until the community in the downstream direction forces them to do so through the activity of some state agency.

There are a few cases where a group of communities may undertake to consider economical co-ordination between sewage treatment and water purification. That situation applies largely to cities taking their water supply from the Great Lakes. These cities gener-

ally dicharge their sewage into the lakes and obtain their water supply from the lakes. They have what you may call the rotary system.

Comparative Costs of Water Purification and Sewage Treatment.

It is necessary sometimes to purify both the sewage and the water supply, and the question arises as to just what it is economical to do. Sometimes municipalities on a given stream may group together in order to handle these interrelated problems.

In order to leave a few thoughts with you on this subject, I might mention that sewage purification as a means of protecting water supplies is generally more expensive than water purification. Broadly speaking, complete sewage treatment which produces a clear effluent, will cost not less than $9 per capita, and may cost more than that, whereas water purification will probably not cost more than $4 or $4.50 per capita. The most elaborate process of water purification will cost not more than $10 per capita. It would seem at first blush as if the tendency should be towards water purification as being the cheaper method of securing the best result, and it is more or less an open question as to which one we are going to hear a great deal more about in the future. It is about time we began thinking of it more seriously.

Another series of items that I would like to consider are in connection with the details of design and operation of water-purification plants.

Advances in Operation of Filtration Plant.

There have been a great many advances in the chemical treatment of water, but I merely want to say that Norman J. Howard, of Toronto, has contributed as much as anybody to the knowledge of the use of chlorine in connection with water purification.

There have been some advances in the method of using coagulation, more particularly with reference to the control by means of observing the hydrogen-ion concentration of the water. It has proved to be a perfectly practical method of maintaining control over the application of coagulant.

Another question that is confusing the minds of water works men is the matter of the preliminary treatment of water with coagulant. It is generally recognized that after coagulant is added to the water, it must be thoroughly mixed. There must be an intimate mixture of the chemical with the water. There is no agreement on just how that mixture can best be obtained—whether by waterfall effect, exemplified by the hydraulic jump, or by a stirring device, or by a baffling arrangement; nor is there an agreement as to the length of time. There seems to be a tendency of opinion in water-purification practice to consider that the important thing is to get a thorough intimate mixture at the start, and that the subsequent mixture is not important. Nevertheless it is probable that there should be a continued mixing of a gentle sort, but for just how long a period is not clearly known; probably from ten minutes to half an hour, but it actually takes longer than that sometimes for coagulation to form. However, it is not of vital importance in securing results.

Then we have sedimentation. There is quite a little to be learned about this. It has generally been by guess, and varies from two hours to six hours. We do not know just what period is necessary. It varies with different waters. There is much to be learned in the shape and arrangement of the basins. Generally we have departed from scientific processes in designing these, in favor of economic construction.

It has been found that double coagulation and double sedimentation is very efficacious, and greatly increases the efficiency of the filtration works and at the same time permits economy in the use of the coagulant.

Then there is the question of dealing with very muddy water, and the removal of sediment. Generally it is done in a sedimentation basin equipped with devises for removing the sediment as rapidly as it forms. That is not a matter that concerns you much in Canada, except in the central west, but it is very important in some of the very muddy middle-western streams of the United States.

Improvements in Under-Drain System.

In connection with filtration, attention has been given to the importance of the under-drain system. There has been practically no change in the general design of filtration units, nor is there any contemplated, but a good deal of effort is being made in trying to improve the under-drain system. One of the important advances in that connection is the cementing of a gravel layer in the bot-

tom of the pit. That was first done by William Gore, at Oshawa, Ont., and has apparently worked very successfully there. Following that, Mr. Jenks, in Sacramento, Calif., devised an underdrain system composed completely of cemented gravel. He cemented the whole business; Mr. Gore only cemented the upper layer. Jenks used vitrified pipe. Lime is used at this place as one of the chemicals for the purification of water.

A good many of the troubles that have resulted from filtration can be ascertained by an examination by microscope, and it is probable that with the proper use of chlorine it will be possible to control the condition of the sand grains so that they will always be in operation. That is something that will greatly improve filtration during the summer, when filtration is most subject to short-run trouble, due to clogging with organisms.

Characteristics of Filler.

Then some thought is being given towards a better understanding of the function of the sand. We have gone along somewhat blindly for a number of years, using sand in a treatment as first devised by Allen Hazen, but I cannot see that there is any reason yet for changing. We have to study the characteristics of the sand from a slightly different angle than did Hazen in 1890. An effort is now being made by filter operators to determine the characteristics of the sand, not as a whole, but as it lies in layers in the sand bed; and they are taking samples at different levels, and examining that sand so that they can express its characteristics by a chart which shows the size of the grains at various depths. That may prompt us to some modification in the sand that will make for efficiency and economy.

Another thing that is being thought of in recent years, and that will be considered a great deal more in the future, is the improvement in the quality of concrete used in water-purification plants. As a rule, water-purification plants call for a very high grade of concrete—the very densest. That has not been given so much care as it should have been given, with the result that some plants are disintegrating, especially near the water line, and especially where you have frost on one side and water on the other. There is a tendency now in specifying the concrete to require the use of the cement-water ratio as a means of securing a definite kind of concrete.

Cost of Water Purification Plants.

Now as to the cost of water-purification plants. We had occasion recently to examine the cost of a large number of plants, some 34, built since the war. They ranged in cost from $16,000 to $50,000 per million gallons capacity. That is for filtration alone, and does not include the pumping station. That seems to be very widespread, but I think that a certain amount of spread is justified for a number of reasons. Some of these filter plants are being built with different water storage basins. That would naturally make a considerable spread in the cost. They are also being built with different sizes of sedimentation basins and filters. Smaller plants will cost more per million gallons than larger plants.

There is a tendency to make plants somewhat more costly than formerly, and I think that it is justified, because they have better arrangements and better means of operation.

Improvement of Operating Personnel.

Another great advance in filtration practice is the improvement in the operating personnel. We are now getting well-trained technical men, and the larger plants are better looked after than they were 12 or 15 years ago. There has been a discussion as to licensing operators. I do not think that the time has yet arrived for licensing operators, because they might protect themselves behind that license in a way that is not altogether desirable. But I would be in favor of giving an operator a certificate of proficiency after he has shown that he really knows how to operate a filter plant.

In closing, I just want to remark that the increasing tendency to house filter plants in well-designed buildings. Both from the architectural and the aesthetic point of view, some of them are actually great monuments to pure water. I do not wish to be in a position of advocating extravagant construction, but I think that there are certain practical aspects about the housing of filter plants in fine buildings. Not many years ago it was the custom to put them in any kind of a building, even of corrugated or galvanized iron. The public appreciate these words more now than they ever did before. I think that somebody has said that art is the striving of mankind to attain to perfection. In a way that is what we water works men are doing

with reference to the production of good water. Therefore I presume that on that basis we are artists. And if that is the case, it seems to me that it is quite appropriate for us to house our water-purification plants in beautiful, noble buildings, that typify and symbolize the most fundamental and important of all commodities, namely, pure water.

HIGHWAY MAINTENANCE IN NEW MEXICO

By E. B. Bail, Asst. Engineer, New Mexico State Highway Department.

The New Mexico Highway Department has established at Encino a department for the instruction of maintenance men.

Primarily the Highway Training School, as the new department is called, exists for the purpose of instructing new employees in their duties, but its scope will be widened to further train men who are already with the department in special phases of maintenance, such as operation of crushing plants and other special equipment.

Torrance County was decided upon as offering the most suitable location for the school. This county is centrally located with respect to the rest of the state and has within its confines practically every type of road and road material. The eastern part of the county has large deposits of caliche; the western half extends into the Manzano Mountains; here are clay roads with their attendant difficulties of maintenance and here are great gravel deposits for surfacing purposes. The southern half is preponderantly sandy.

During the winter months drifting snow is the largest factor to be dealt with; in the spring blow sand must be fought in the country around Mountainair. To sum up, every difficulty a maintenance department must face, is met in Torrance County and students will be trained to cope with all of them.

The school assumed working form when L. C. Tucker arrived at Encino Feb. 18th to take active charge. The state had previously acquired a machine shop and garage at Encino, and repairs were at once started on the patrol equipment in the district. Three 10-ton tractors with heavy graders, together with several F. W. D. trucks and necessary equipment, are being used by the student employees.

At present twenty-five men are in training. These men are from all sections of the state, Spanish-Americans predominating.

Under present practice the district engineers select the men they wish trained. The men bring their bed rolls and pay their transportation. They are furnished steel cots on arrival at the school. Bunk houses are provided and those who wish to do their own cooking are allowed the use of cook stoves for which they must themselves furnish the fuel. They are paid $2.50 per 9-hour day.

Ordinarily the district engineers advise the school superintendent what, in their opinion, the men they send are best qualified for; as truck driver, grader, runner, patrol foreman, etc.

However, all students are first introduced to the grader, this machine being an indispensable part of every patrol's equipment. They are thoroughly familiarized with the operation of the machine. At this stage of their instruction two or three students are assigned to each grader. After a week of this work in which time they have come to know the purely mechanical part of the operation they are taken singly and given a stated section of road to build, repair, or widen. Right at this point it will become apparent whether or not a man can be made into an efficient grader runner. A grader is an innocent looking affair and it would appear to the casual observer that nothing could be simpler than to operate one. But to operate one properly, to get a good job, one must have an "eye," as the expression is and not all men are so gifted. Men without the "eye" can be made into "so-so" runners, but the resulting product is not worth the expense.

Men unable to qualify as grader runners are tried out on trucks; if they cannot demonstrate ability to look after such equipment properly they are classed as common labor and released from the school.

For rating purposes the school classifies men who complete the training as truck drivers, tractor drivers, grader runners and patrol foremen. A good patrol foreman should be able to fill any of the above mentioned positions, except that he need not necessarily be an expert tractor driver, although he should understand tractor operation

and know when he is getting results from this sort of machinery. In addition to being able to do the things enumerated above, the patrol foreman must be able to handle men and to get the most out of labor under his supervision. He must be energetic and ready and willing to get his crew onto the roads when weather conditions demand it, and he must be able to keep them there while favorable working conditions exist regardless of Sundays, holidays and regular working hours. Men of this type are hard to get; the school cannot insure that the men it turns out are of that type; a man may be able to perform all the mechanical operations efficiently and yet fail in the test of actual maintenance because he lacks that essential requirement which may be briefly described as "guts.'

No definite period has as yet been settled upon as being the minimum time in which a student can be trained; naturally the time required will depend on the individual. It is believed that thirty days should be the shortest time given a student. It is felt that if a man shows sufficient interest in the work to pay his transportation to the school and put in nine hours a day for the small wage paid he is entitled at the least to a fair try out, and if he evidences a willingness to work after he gets there he should have at least thirty days to demonstrate his ability.

It is believed that, to get the maximum of individual instruction the school should not have under training more than thirty men at any one time, as this number represents about all that can be handled on the equipment required to carry on the regular maintenance work of a district the size of Torrance County.

Men who display a more than usual aptitude for handling equipment will be selected for training as tractor drivers, for these heavy machines require a closer supervision and a more intelligent class of operators than are apt to be found on the average patrol.

Repairs to equipment required for the school are handled in Encino Shop, which is being equipped to handle promptly all types of trucks and tractors in use in the state.

ELECTRIC DRIVES AS COMPARED WITH OLDER METHODS

By R. H. Rogers, Industrial Engineering Dept., General Electric Co., Schenectady, N. Y.

(A paper presented before the American Society of Mechanical Engineers.)

It is the purpose of this paper to outline some of the broader and perhaps less obvious effects of electricity in industry. The immediate physical effects following the adoption of electric drive; such as reduction of power requirements, elimination of shafting and belts, and the attainment of greater flexibility in the application of power; have been repeatedly and copiously brought to the attention of all concerned. There are several deeper and more far-reaching conditions and effects to the credit of electricity that have not received such generous attention.

Between 65% and 70% of all the power used in American industries is electric and the growth of this type of power is far greater than the total growth of power industry. It is significant that the newer plant in an old established industry are the most nearly 100% electrified and that the newer industries, such as the automotive activities, are, and have been from the first, practically 100% electrified.

Our industries, in 1927, will use approximately 50 billion kilowatt-hours of electric energy, two-thirds of which will be purchased from power companies and one-third generated in private industrial plants. We can neither foresee the time when all industrial power will be electric nor when all the electric power will be purchased from central station systems. Many industries are characterized by the presence of by-product heat or by-product fuel or by uses for process steam. These items, together with privately owned water power sites, will long continue the use of other than electric power as well as the operation of private electric plants.

There is a strong trend, in the presence of by-product heat, by-product fuel or private water power, to convert to electricity as the medium for getting the power to the work to be done. The same is true where low pressure process steam is required, as it is a quite general practice to utilize the exhaust or to bleed low pressure steam from the turbine of a turbine generator, the electrical output of which is used to drive machinery.

Having thus outlined the place of electricity in modern industry, some of its broader effects may be noted.

The first effect is the retirement of industrial plants to large industrial centers. Early operations were established at water power sites or in parcels along a stream to utilize several small water powers. Certain classes of work using great amounts of power on products of low unit value were for long considered feasible only with direct water wheel drive. The advent of electric power has changed all that. The small water power sites have passed out of the industrial picture. They are now combined into fewer heads and are driving hydro-electric stations tied in with steam stations to form great stable systems. The various enterprises are now fewer and larger. They are located in advantageous centers and enjoy full power the year around. Many times it has happened that a half-dozen or more industries along a stream have pooled their water power rights, rescued the power formerly lost between plants, organized a hydro-electric company, reclaim all the power required for their own use and market an equal amount of surplus power. The tie-in with other systems has given stable power and the old power limit to their expansion has been removed so that they are free to grow how and where they please without having to consider getting power from the old water-wheel shaft to their manufacturing processes.

My second consideration regards the change in conditions for the personnel of industry. The little bleak, monotonous mill town is passing, men and women find their employment in large towns and cities where they can live broader lives. Their churches, theatres, contacts with people otherwise employed and the conveniences and facilities at hand make for contentment and a negligible labor turn over.

From another standpoint electric power has revolutionized processes and made possible great concentration of power under the control of few workers. A man having the power of 10,000 men under his hand must be inspired and uplifted by his commanding position as compared to one who labors only with the power of his own hands. The President of the American Federation of Labor has said that electric power with all that it entails is the greatest single factor in the shortening of working hours for American industrial employees.

A third angle from which we might view this general subject is that of the release of space and capital for application to production. Under the older systems a considerable portion of plant space was given to the production of power, either in a centralized powerhouse or more often in a number of scattered boiler and engine rooms, or water wheel housings. Purchased power particularly has made it possible to utilize practically every foot of plant for production, to say nothing of the bettered conditions for production which have been thoroughly covered in numerous publications.

Capital investments, overhead, and operation costs, are heavy items chargeable to power plant equipments and worst of all they are usually administered by those whose prime interests are in the manufacture of some product other than power. Purchased power has therefore made available for direct application to production millions of dollars that would otherwise be tied up in the more or less inefficient production and distribution of power.

Conservation of our natural resources, our fourth effect, is not the least valuable of the functions of electricity. It has made available vast water powers with consequent direct saving of coal and it has, by concentrating steam power production into gigantic stations, reduced the coal requirement per horsepower as much as four fold. Furthermore, it has made available for power purposes much of that wealth of by-product heat and by-product fuel that has in past years entirely gone to waste.

For the fifth subdivision of the subject we may consider the high rate of production that now prevails through the agency of electric power.

The ways in which production has been speeded up are so numerous and divergent that we can only dwell upon a few of the outstanding instances. The manufacture of paper is a good example because electric drive has pushed up production rates in all branches of the industry. Water wheel driven pocket type grinders for making wood pulp have given way to motor-driven magazine type grinders utilizing motors of 2800 horsepower. They are most economically arranged and ton for ton require only one-seventh the labor formerly needed and the work is carried out on one-tenth the ground space.

The paper machines were limited by mechanical drive to speeds of 500 or 600 ft. per minute and in widths to less than 200 in. With individual electric drive the common speeds are now 1000 ft. per minute with 1200 ft. attained in some cases. Certain new machines are designed for an ultimate speed of 1450 ft. per minute and widths are now up to 270 in. or for a trimmed sheet 22 ft. wide made at a speed of over fifteen miles per hour. With all this speed, reliability has been bettered and sheets 700 miles between breaks have been produced, while maintenance costs of the drive have dropped to one-fourth the figures that held for the older drives.

Woodworking in all its details has been speeded up. This effect is felt from logging and yarding clear through to the manufacture of the finest of wood products. Huge head saws tear through giant logs at unbelievable speeds under the urge of the relentless electric motor. At the other end of the scene tiny motors driving sanders, molders, tenoners and the like run at speeds unattainable by mechanical arrangements of gears or belts. Some run as high as 30,000 revolutions a minute with consequent rapid feeds and savings of rehandlings for grain directions so that production is speeded up to keep pace with these electrical times.

An abrupt change of thought brings us to the effects of welding by electric arc in manufacturing. The adoption for production purposes of this process which only a short time ago was looked upon as a means for making repairs or as a "putting-on tool" has been so rapid and far-reaching that the general public and even those more intimately connected with the metal world are as yet unaware of its scope.

Arc welding for thousands of products does away with patterns, castings together with casting losses, much of machining and withal results in lighter, stronger and better construction. It reduces necessary stock of materials and parts, and greatly shortens the time from completion of design or receipt of order to the finished article. The electrical manufacturer has not been slow in taking liberal doses of his own medicine, particularly is this true of General Electric where the arc weld has made possible marked reductions in the space occupied, in the time required and in the developments and shop costs of many of our major products.

Electric heat, while old in theory, has only lately come into prominence as a feature in manufacturing. The growth of heating loads on central station systems is astounding and it is freely predicted that its possibilities equal those of electric power. Wherever it is used, the result is a speeding up of the process coupled with better and more uniform results and a reduction in maintenance costs.

The sixth and last phase to be considered here is that of production costs. Costs are naturally reduced if power is delivered more cheaply at the place where the useful work is done. With the exception of the aluminum and ice industries the cost of power runs from one-half to six cents per dollar's worth of product. A change of 25% either way in power cost would therefore affect total costs but little. The summation of the less tangible advantages of electric drive is of far greater importance and that is what has brought electric drive into undisputed leadership. The saving on capital charges and the release of space to other uses wherever electric power supersedes the older methods, has been outlined in previous paragraphs. We will now review some of the other ways in which production costs are affected.

Mining calls for the use of the largest power shovels for stripping overburden. Electric power shovels, besides lowering the visible costs per cubic yard show remarkable superiority from the maintenance standpoint. The largest steam power shovels require approximately $25,000 per year for maintenance, whereas the corresponding electric shovels are maintained for $5,000 per year. Little of that expense goes into the electrical features. The principal differences are in the steam plant upkeep and general repairs and replacements. Electric shovel drive, while more forceful than steam, has the faculty of minimizing shocks and strains so that with greater yardage the wear and tear is wonderfully reduced.

Mine hoists are among the most interesting power applications and developments have been carried to a point where no other form of power could possibly meet present-day duty cycles. The result is reduced cost of production because, in addition to lessening the cost per ten foot of hoisting duty, fewer

shafts are required and less additional expense is incurred as mines are deepened or output is increased.

Oil well drilling and pumping illustrates well the importance of what at first appear to be secondary considerations. While the power costs per foot drilled or per gallon pumped are primarily considered probably more owners are influenced by the reduced costs attributable to greater continuity of service, lesser capital investment and the improved conditions as to fire and personal hazards.

Steel mills are among the greatest users of electric power and the newer the mill the more nearly will it be 100% electric. Lowered production costs are obtained through being able, with electric power, to do things in ways and at rates that would otherwise be impossible. Concentration into great units reduces the labor cost even more than it reduces the power cost.

The large new paper mills, entirely electrified, using gigantic units, have cut production costs so that smaller old style mills are hard pressed or have given over their water power sites to hydro-electric stations. These results are not so largely credited to cheaper power as to reduced labor, reduced maintenance and more perfect continuity of manufacturing operations.

Examples without end could be cited to show the less conspicuous ways in which electric power reduces production costs but enough have been given to indicate that the more obvious characteristics are often of minor importance.

Summary

A summary of the effects of electric drive compared with older methods as noted in this paper, will serve to bring out more clearly the salient points.

1. Location and plant-plan freed from the old limitations as to source of power and its distribution.
2. Improved living conditions and a general uplift in personnel.
3. Release of capital and space for direct manufacturing operations.
4. Conservation of coal and oil by utilizing water power and by using fuel more effectively.
5. The speeding up of production makes more output possible per unit of space and per man-hour of labor.
6. Reduction of production costs results from various combinations of all the above, together with marked reductions in the cost of the power that is actually delivered to the work to be done.

CITY MANAGER GOVERNMENT PRONOUNCED FAILURE AT KNOXVILLE, TENN.

By Robert D. Burns, Associate Editor of "Opinion," 54 S. Fitzhugh St., Rochester, N. Y.

(Editors Note: The following article is reproduced from "Opinion," an independent weekly journal of discussion, published at Rochester, N. Y. We gather from this and other evidence that Rochester, like Indianapolis, is in the throes of a city manager discussion. We recall reading the valedictory of a Knoxville City Manager within recent months. It was a well-rounded "cussing out" of the Knoxville politicians, who, according to the ex-manager, are fit only for treason, stratagems and spoils and are not to be trusted.)

Hard words for the city manager government boys come out of Knoxville, Tenn. Three councilmen in that fair city, which for the last three and one-half years has been operating under that upandcoming plan, send out a fervent prayer that no other American city will become a victim of the city manager scheme. We read that it has been a miserable failure in Knoxville, a delusion and a snare, and the transfer of power from the many to the powerful few.

Rochester's city manager charter is on the way to the Court of Appeals. The recent decision of the Appellate Division left this model baby in the state in which it was born and adopted by the Common Council. The high court of the state is expected some time this summer to pass on the legal issues raised against the new charter, and decide whether Rochester is to operate under a new form of Government the first of the year.

In the meantime while the local unterrified yeomanry await word from the civil tribunal it is interesting to note that this highly spoken of plan of municipal salvation recently was repudiated by the citizenry of St. Petersburg, Florida, where so many residents of Rochester and Western New York hibernate.

The vote cast was one of the heaviest in the history of the southern city. Out of a total of 5,496 ballots, 3,321 were cast against the city manager charter, and only 2,175 in its favor. In Rochester the plan got by the voters simply through

the indifference of a large number of the electorate. This is not the time to speak of that phase, as the whole inspired writing is to be legally analyzed in the highest court of the Empire State.

If the Court of Appeals upholds the validity of the charter then Rochester voters will choose a House of Lords at the November elections, and this peerage will provide a Moses to lead the people out of Egyptian Rochester. Love will find a way.

On the other hand if the city manager charter is scrapped in the high court, the people of Rochester will continue under the old charter, which the New York Bureau of Municipal Research, pinch hitting for the local bureau of the same name, said "is very like the charter of an ordinary business corporation."

This is the form of government along business lines which the city manager, if he ever lands, is expected to administer. So what is there new outside styles of bookkeeping, local representation shifted from the 24 wards of the city to four topheavy districts, selection of responsible heads of departments taken from the people, a mayor who is to wear a longtailed coat, a plug hat and greet visiting Rotarians and other holy persons, and do nothing else for the honor of the name?

But to get back to the boys who walloped the city manager plan down Florida way. The proposed charter for St. Petersburg was supported by the Times of that city. J. W. Falconnier, managing editor, led the fight for his newspaper He is a former resident of Knoxville, Tenn. Against him were the administration forces, union labor and The Evening Independent. One of the woes of the defeated journalist was the fact that three councilmen from his onetime home town, Knoxville, delivered the blow that killed the city manager plan in St. Petersburg.

The Times in the heat of the charter campaign reprinted a story from the Knoxville Journal to the effect that Knoxville under the city manager plan had reduced its tax rate from $29 a thousand and that a tax rate of $17.50 was in prospect. On reading this story in St. Petersburg, C. M. Blanc, former mayor, and a member of the city commission, who was seeking re-election, telegraphed his brother, T. A. Blanc, a councilman under the city manager plan in Knoxville, to send him material on the city manager government in the Tennessee city. The reply, signed by three of the Knoxville councilmen, branding the city manager plan in their city a "miserable failure," was utilized in the St. Petersburg campaign. Here it is:

"Knoxville, Tenn., May 13, 1927.

"C. M. Blanc, St. Petersburg, Fla.:

"City manager government in Knoxville in existence for three and one-half years miserable failure. The tax burden has been doubled and the debt has been doubled without commensurate returns.

"The theory of free government, such as forms the foundation of American principles of government, is destroyed and the government is placed in the hands of the powerful few.

"The people rapidly lose control of the agencies of their government. The Knoxville experience under city manager government has seriously impeded expansion and progress of the city and generations yet unborn will feel the bad effects of this experience.

"The people of Knoxville are waiting the first opportunity to throw this governmental monster out of their city.

"The city manager government is a haven for useless experts and parasites who flock to its standards for the loaves and fishes.

"As three councilmen, two of whom were elected in the recall election, we sincerely hope that neither St. Petersburg nor any other city will be required to pass through the same sad experience as that of Knoxville, and that the wreck of the City of Knoxville will stand as an everlasting beacon to guard her sister cities from the shoals and rocks of the city manager government which is a snare and a delusion.

"O. P. STERLING,
"LEE MONDAY,
"T. A. BLANC,
"City Commissioners."

On the strength of this telegram from Knoxville the foes of the city manager plan of government in St. Petersburg routed the factions that favored the importation of a municipal Moses who was to give a pure business administration. This scheme in Rochester has been fostered behind experts in the Bureau of Municipal Research. As pointed out above, the fate of Rochester's model baby rests with the Court of Appeals, but the sponsors who put over the charter at the polls are in the same school

of experts who back in 1915 made this admission:

"The study just completed of the organization and administration of the City of Rochester has developed a number of points of unusual interest—among them is the fact that the oldstyle charter which provides for a single executive and a large council is not essentially bad.

"Years ago this was the prevailing type. Officers became wasteful if not corrupt and inefficient. The political reformers said—'the charter is at fault, let us have a new charter that will provide for filling the important places by popular election.'

"Officers continued to be wasteful, if not corrupt and inefficient. Again the political reformers said—'the charter is at fault, let us have a charter that will provide for government by a small commission.'

"Still in many places the officers continued to be wasteful and inefficient, and political reformers are again saying—'the charter is at fault, let us have a city manager plan.'"

Here are enumerated three stages on which political reformers strutted, the latest being the city manager plan. At this time it is profitable to read what the experts had to say in 1915 of the city government of Rochester. The citation is from the report of the New York Bureau of Municipal Research which made the survey here for the Rochester Bureau of Municipal Research. In the introduction to this report, page 1, appears:

"Rochester holds to the old style of charter—a mayor and a council made up of 23 members, one from each ward. The New York Bureau of Municipal Research has made administrative studies in some fifty different local governments and comprehensive studies of 25 city governments, and, notwithstanding the fact that Rochester still retains the old type of organization, the results and conditions which were found there are superior to those which have been found in any other city; not that Rochester has a government which is beyond criticism, as there is obvious opportunity and need for improvement. But speaking comparatively, Rochester's government is better organized and better managed than any which has come to the bureau's notice."

So that is how the New York municipal experts disposed of the political reformer's plea for a city manager government away back in 1915 before the corporate interests in Rochester dominated by the powerful few, were sold on the city manager plan.

The warning from the three councilmen in Knoxville is published here for just what it is worth to the thinking taxpayer, and for nothing more. An indifferent electorate which failed to mass a telling vote when this charter was presented to the people, so that the issue might have representative thought, is culpable in the premises. The charter gives amazing powers to the council to be elected in November, provided the courts permit, and the more the voters of Rochester read of the operations under this city manager government in other American cities, the better advised respecting their individual interests will they become, and the more wary in yielding their present control of city affairs to an oligarchy.

CLEVELAND CONCRETE FOUNDATION PIERS MUCH THE DEEPEST EVER BUILT

By **Frank W. Skinner**, *Consulting Engineer, 20 Vesey St., New York, N. Y.*

All depth records for piers built by the pneumatic caisson, open pit, or dredged caisson methods have been greatly exceeded in the construction of the substructure for the $11,000,000 Cleveland Union Terminal Building, Cleveland, which has 79 tall and slender cylindrical concrete piers built in wet plastic clay, through which some of them are carried to bed rock at a depth of 260 ft. below the highest point of the surface. All work was done in the dry in open pits sunk by the Chicago well method, the clay, being largely excavated by about 20 Chicago Pneumatic Tool Company's pneumatic spades, and the wells, from 4 to 10½ ft. in diameter, being immediately sheeted with tongue and groove vertical wooden staves bearing against inside top and bottom steel hoops.

The depth of the wells, although equal to the heights of the piers, is less than the distance from the surface of the ground to the bottoms of the foundations because the whole area of the building was excavated to a maximum depth of 52 ft. by a fleet of steam shovels before the well excavation as such was

commenced by sinking rectangular pits sheeted on top with boards, and below ground water level with about 200 tons of 12-inch Lackawanna steel sheet piles driven by steam hammers suspended from the 35-ft. boom with which an Erie steam shovel was equipped.

After the excavation had reached the very thick stratum of plastic clay, the sheet piles were replaced by vertical staves already mentioned and the work progressed continuously by successive 7½-hour day and night shifts.

The largest and deepest pits extended down to bed rock about 210 ft. below the general excavation, the smaller ones at a maximum diameter of 4 ft., averaging about 100 ft. deep. Spoil was hoisted in cylindrical buckets operated by 20 2-horsepower electrically-driven Thomas single-caisson winches and by six Thomas double-drum hoists operated by 20 horsepower electric motors and hoisting the large buckets with a 2-part line at a speed of 100 ft. per minute. The buckets were provided with safety hooks attached to the 4-strand ¾-in. parafined Manilla lines furnished by Roebling and the ⅝-in. Hercules red strand rope made by Leschen. The muck, delivered to the surface of the ground was loaded in large side-dump cars by a Marion steam shovel previously used for the general excavation.

The general excavation was drained by four 3-in.. Domestic gasoline-driven pumps on hand trucks and most of the large quantities of water encountered in the lower part of the wells was handled by two 3-in. centrifugal Economy pumps driven by 10-horsepower Star electric motors, mounted with them in housings suspended in the wells. When the first pump had been lowered to a depth of 100 ft. or more it remained stationary and was served by a duplicate pump continuously lowered so as to keep just above the bottom of the well, and having its discharge pipe connected to the section of the upper pump that delivered directly to a drainage ditch at the surface of the ground. These pumps each had a capacity of 200 gals. per minute with a 135-lb. head and successfully performed the heavy duty without delay for repairs.

The squeezing, so often present in plastic clay excavations, threatened in some cases to collapse the sheeting of the deep wells and was resisted by large numbers of sectional horizontal wood drums adjusted by pairs of 15-ton jackscrews between which there was clearance for the passage of the muck buckets. About 100 of these drums were provided and sometimes as many as 20 were required in a single well in which they remained until displaced by concreting. Wooden staves and their steel hoops remained permanently in position, after the completion of the foundation piers.

The greatest difficulty was due to the presence in the clay near the bottoms of the wells, of large quantities of methane gas, an odorless, colorless, tasteless, inflamable and explosive gas that has in former years caused many deaths in the tunnel excavations through the same stratum in Cleveland. Its invisible presence was detected by the bubbling up through water in the bottom of the wells, and by a number of Wolf safety lamps which indicated the presence of very small quantities by a flickering flame, which would be automatically extinguished long before the proportion of gas became dangerous.

The gas was diluted and removed from the well by large quantities of pure air at 10 lbs. pressure forced to the bottoms of the wells by a 1,000-ft. Connorsville blower and by the exhaust from the pneumatic spades as well as by the plunger action of the comparatively large ascending and descending buckets. No gas accident occurred in the wells, although an extraordinarily large amount of gas collecting above the surface of the ground at the top of one of the wells was accidentally exploded burning a number of men so severely as to require hospital treatment, from which they all recovered.

About 20,000 yds. of muck were excavated from the foundation pits and about 18,000 yds. of concrete were required to fill them. Large quantities of fine and course aggregate were stored in heaps in the bottom of the general excavation and were thence transferred to elevated hopper-bottom wooden bins delivering by gravity to the 28-S Lakewood mixer operated by a 4-cylinder Model O Hercules engine and delivering a maximum of 750 yds. per day (which was mixed and placed with a total force of about 12 men) to the buckets at the foot of a guyed 240-ft. steel Insley tower whence the concrete was spouted to position through more than 300 ft. of steel chutes supported by the Insley system of counterbalanced trusses and an 1½-in.

high line cable which commanded all parts of the 260 x 300-ft. area occupied by the 52-story building more than 700 ft. high above the curb which has a 17,000-ton steel framework fabricated by the American Bridge Company and erected by the Bass Construction Company.

Notwithstanding serious labor troubles the substructure work was executed by Spencer, White & Prentis, New York, approximately on schedule time in about nine months by a maximum force of 250 men. H. D. Jouett is chief engineer, for the $11,000,000 building; Graham, Anderson, Probst & White are the architects, and John Hill & Sons, general contractor.

THE MISSISSIPPI RIVER FLOOD PROBLEM

By Robert P. Howell, Major, Corps of Engineers, U. S. Army, Formerly U. S. Engineer, Vicksburg, Miss., Dist.

(From the *Military Engineer*, May-June, 1927.)

As pointed out in an article on this subject in the issue of *The Military Engineer* for July-August, 1924, the immense areas now overflowed, or threatened, are in reality high-water beds of alluvial streams. They have been built up from the sea bottom by the Mississippi and its lower tributaries, such as the White, Arkansas, and Red Rivers. During successive ages, the lower end of this bed has been slowly extended into the Gulf of Mexico, while high waters have gradually raised the height of its more northern regions above sea level. However, since the river put this land where it is, it follows that, under natural conditions, a sufficiently large flood would overflow it.

Accordingly, early settlers in this region generally avoided the alluvial bed, preferring the high bluffs at Baton Rouge, Natchez, Fort Nogales (Vicksburg) and Memphis, on the eastern bank of the Mississippi, or the highlands at Natchitoches, Louisiana, on the Red River, and at Arkansas Post on the Arkansas River, west of the overflow basin. New Orleans, founded in the midst of the delta, as a seaport, was promptly protected by a levee begun in 1717. Tempted by the fertile soil, settlements were later made at high points along the river banks, and they, in turn, were surrounded by small levees to protect them from the occasional excessive flood. But such centers of civilization were isolated. Communication overland between them was possible only at the end of the low-water season, when wagons could cross the dried beds of the innumerable bayous and sloughs which formed a network of interconnection between the larger streams during high water. Most travel was by boat, and trade with the outside world was generally restricted to the high-water season.

Schemes for Protection

As settlers increased, more local levees were built, which were gradually connected into levee systems. Forests were felled and farms cultivated under their protection; factories were erected, cities grew; and roads and railroads were built. The "delta," which extends on one or both sides of the river from Thebes, Illinois, to the "mouths of the Mississippi," includes a fair proportion of the entire surface of the United States, and now forms an important part of our economic and industrial structure. It must be protected from overflow. This area not only produces much of our cotton and hardwood lumber, but, if it were left to the mercy of floods, New Orleans would be isolated from the rest of the country, and there could be no transcontinental railroad south of Thebes. Of the numberless schemes of protection, in addition to levees, which have been suggested, only these appear at all plausible: impounding reservoirs, reforestation, outlets, and spillways.

A system of reservoirs at the headwaters back part of the water and release it after flood stages, appears the most alluring. Its advocates cite the regular flow of the St. Lawrence River, draining the Great Lakes, as an example. Unfortunately, when applied to the Mississippi, the scheme is not practicable. Not only are the stupendous reservoirs which would be required now occupied by farms and cities and traversed by important railroads, but many of the storms which cause floods occur below the feasible sites for reservoirs.

Some fifteen or twenty years ago, the replanting of forests at the headwaters was hailed as the panacea for all flood troubles, but the theory that forests have any important effect on flood heights is now generally discounted by those who have investigated the subject. In any event, the same objection applies to forests as to reservoirs. They are not practicable. The former forests are now farms, and it would be economically fool-

ish, if politically possible, to move the farmers out and turn their fields back into forests.

The outlet system contemplates additional channels, paralleled by levees, to carry part of the flow and consequently reduce the height in the main stream. It is physically possible, but a fraction of the cost of dredging the canals, constructing the levees, building railway and highway bridges, and paying for damages to lands and structures, would construct levees in the main system much higher and safer than those now built.

A spillway is a cut in the levee, which may, in some cases, be closed by a gate. As the water approaches a critical stage, the spillway comes into operation and part of the stream is allowed to pour on the adjoining land. (If the outflow must be confined between levees until it reaches gulf level, the spillway becomes an outlet.) Whether or not a spillway of feasible size would have an important effect on the height of the river during a large flood, is a matter of considerable dispute. A board of officers, appointed by the Chief of Engineers, United States Army, under a recent act of Congress, is now investigating the subject. But a spillway must necessarily be restricted in location to the extreme lower reaches of the Mississippi, in the vicinity of New Orleans. The rest of the valley is now too highly developed to be overflowed, even at rare intervals, without disastrous results.

Levees the Practical Method

It therefore appears that dependence in the future, as in the past, must be placed on levees, which confine the river to a width only a few times greater than that of its present midstage channel in its alluvial bed. The belief that the bed of the Mississippi is rising is probably caused by increasing stages, as the floods are better controlled. Investigation shows that the bottom of the channel is in reality being appreciably, although not effectively, lowered. The main technical question involved is the determination of the minimum height and size to which the levees must be constructed at any particular locality, in order to confine the maximum flood.

Unfortunately in considering flood control on the Mississippi, the ordinary methods of hydraulic engineers are not entirely satisfactory. Amounts of rainfall, rates of run-off, velocity and volume of flow over such a vast area, the effect of tributary floods on a swollen main stream, the increased height due to confining the water—all combine to produce a problem which becomes hopelessly complicated and involved and make a reliable prediction improbable. The only feasible method evolved so far is the practical one of "cut and try," influenced, of course, by records and experience, and aided by such principles of hydraulics as can be applied. The "provisional grade," established by the Mississippi River Commission in 1914, was based on raising the levees to 3 feet above the height to which it was thought that the 1912 flood would have risen had it been confined throughout the length of the river. The 1922 flood, which exceeded the previous record in the lower river, and which was carried as far as Natchez without a break, indicated that the grade might be considered substantially correct, except for local adjustments. The present flood, however, will probably cause considerable raising of the Commission's grade in a number of stretches.

The awful loss now occurring in the path of the flood, even from a material standpoint only, is sickening to contemplate. Towns and villages have been washed away, railroad beds and highways destroyed. drainage ditches filled up, crops ruined, and cattle drowned. Thousands have lost all their possessions and communities have been laid prostrate. But the work will go on. With the fine courage which they have shown for a hundred years and more in their contest with the Father of Waters, the local people will return once more to their homes, and aided by a sympathetic national government, will take up again the task of making their defenses so high and strong that the dwellers in the valley will feel as secure as those on the hills.

PAVING ALONG STREET RAILWAY TRACKS

By J. I. Catherman, Engineer Maintenance of Way, Illinois Traction System.

(Paper read at 1927 meeting of Illinois Society of Engineers.)

Back in 1888 the first electrified city railway began operation in the city of Richmond, Va. Before that, old Dobbin held sway as the motive power of the street car. During the 39 years intervening the electric railway has shown wonderful strides in every phase of its operation.

New problems have cropped up continually. In rolling stock and track design have been the most notable changes. In paving there has also been made some wonderful improvements. We have gone from the very small car seating a dozen or so people to one seating 56 people, and back again to the one-man car seating 30 people; from the car weighing 4 or 5 tons to the car weighing 18 tons and back again to the car weighing 8 or 10 tons.

Track construction has gone from the old 40 lb. and 60 lb. Tee rail up to the 9 in. girder rail weighing as much as 174 lb. per yard. From read oak ties to treated ties each protected with tie plates, all steel ties and semi-steel ties, rail fillers, from common angle bars to welded joints, from a few inches of gravel ballast, in many cases, to a foot of stone ballast, to concrete slabs beneath that ballast, or to a sub-structure encased entirely in concrete. And lastly, but not least by any means, from a paving structure consisting of a layer or two of brick laid on a sand or gravel bed, to brick filled with asphalt, to granite blocks or to a track structure entirely encased in concrete paving. The paving problem which started when old Dobbin trotted down the center of the track is still with them and has become an increasingly serious one as the years have gone by.

The track structure itself is the first consideration and to it we must first turn our attention. Upon its proper construction depends, to a very great extent, the life of the pavement.

Specifications as Related to the Street Railway Track

As engineers I believe that you can readily see that no particular set of specifications can be set up to cover street railway track construction. Barely any two cities have the same natural problems, so that to set up a standard set of specifications and say to the industry "you must do this here" and "you must do that there" would be as futile and ridiculous as to say that by assembling together a number of definite, but different units, there can be manufactured one best automobile or one best radio.

Such a standard specification, or standard design, to cover all cities, and all conditions, would necessarily have to be so rigid and so broad in its scope that it would work an unnecessary financial hardship on many of our properties and would probably not even give the best results to many properties who really were financially able to comply with them. Not only must economy in first cost be considered, but economy in future maintenance as well. Track, just as anything else, will wear out, and must at certain periods be completely rebuilt and it should be so designed as to give the maximum amount of life at the most economical cost, the minimum of maintenance required and a maximum amount of salvage when reconstruction does finally become necessary.

Experience, both of ourselves, and of others, is the guide to which we must turn and this experience must be based on personal contacts and personal observation over a period of years and under all sorts of local conditions, and not upon the sometimes highly camouflaged and glossy reports we often receive.

The first problem which confronts the street railway engineer is that of weight of rolling stock, the volume of traffic and the probable future of such traffic. Upon these three things depends the entire design of the track structure.

Soil Conditions

The next factor is that of the condition of the soil upon which the track is to be constructed. This phase of the subject is one to which too little attention is paid and has unquestionably been responsible for the complete failure of many pieces of railway track. The soil in barely any two of our cities is exactly alike and each individual condition must be studied if the best results are to be obtained. A soil which under ordinary natural conditions would not support a track structure might be made to support it if proper precautions are used. Stone may be rolled into the subgrade to bind it together before the ballast is laid, a concrete slab may be installed to support the ballast or many other schemes may be carried out. With them all, however, the drainage problem must be considered and proper precautions must be taken to so drain the sub-grade, or road-bed, that it may at all times be free of moisture. A few dollars spent in drainage will return themselves a hundred fold when future maintenance is considered.

The Matter of Economy

The third, and probably the most important factor, is the one of economy. This factor confronts the railway engi-

neer continually and in meeting this requirement he is called upon to exercise his greatest ingenuity. Too often indeed, the engineer stands as a buffer between his management and the local board of improvements. The street railway manager has his own ideas as to how much money can be put into a piece of track, the local board has set ideas, usually dictated by their engineer, and the railway engineer also has his own ideas. In striking a happy medium he is often put to his wits ends in obtaining a job that will stand up under the traffic to which it will be subjected, require a minimum of maintenance and still satisfy all those concerned.

Local conditions also affect this economy bogey. One engineer may say that 8 in. of stone ballast is all that is necessary, another may say a foot is required, or that the ties should be entirely encased in a slab of concrete in order to obtain the best results. Both may be right. Their local sub-soil conditions and the volume of traffic over their track absolutely govern these features.

The Ties

After the sub-grade is prepared and the ballast installed we have the ties. One engineer may think an untreated white oak tie is sufficient, that a more expensive tie is unnecessary; another may think that to construct track of untreated ties is nothing short of a crime. My personal experience in constructing track for heavy electric traction, is that for such traffic, sawed 6 in. x 8 in. or 7 in. x 9 in. red oak ties, creosoted, either by the full cell or empty cell process, and tie plated is the proper class of tie to be used in pavement. For city railway service only, the all steel or semi-steel tie, encased entirely in a slab of concrete will provide a base of sufficient strength to carry traffic, is an economical construction and will have a life as long as the wearing surface of the pavement at least, and possibly longer. Again the matter of economy pops up. White oak ties or some other good tie may be obtained locally in quantities, while the treated tie or the steel tie may have to come from a considerable distance and its cost by the time it reaches the job, may be excessively high. It is then up to the engineer to make the best of his opportunity, provide a well drained road-bed, and surround the tie with such other conditions that it will give a maximum of service.

The Rail

Our next problem is the rail and it is here that Heinz with his 57 varieties has nothing on the railway industry. Rail can be found suitable for any weight of rolling stock, for any kind of wheel flanges rails that will comply with franchise requirements and the desires and arguments of city engineers and local boards of improvement, and rails that wont, and the manufacturer will roll almost any kind you want. One of the greatest blessings that could come to the railway industry would be a committee of our railway organizations with courage enough to set forth specifications covering a few types of rails, rails that would take care of any kind of traffic and under any kind of conditions, and added to them, manufacturers who would say, "We will roll these rails and no other." I am firmly of the opinion that all of the requirements of all the electric railways of the country could be centered on possibly a dozen types of rail. Prices would be decreased, deliveries would be enhanced and the benefits to be derived would be unlimited both to the manufacturer and to the user. I have certain set ideas of my own in this regard. To go deeply into this phase of the subject might simply open up an argument which would take up more time than is available at this meeting.

Looking at the structure of the track in general. As I have said before, no one set of specifications can or will meet all conditions. Each property has its own problem, it may be in sub-soil conditions, it may be weight of equipment, it may be a particular franchise requirement, or it may be entirely one of economy, or possibly a combination of all. The problem may simply be the desire of the local management to build for their own immediate future and to leave the road of 25 or 30 years hence to their successor. This spirit of alleged economy too often, in the past, has governed our railway construction, but our railway managers today, I believe, took at the problem in a different light and are building not only for themselves, but the best they know how.

Track Paving

We now come to the peak, or culmination of our discussion. That is the paving along our track, the wearing surface, if you please, of the entire track structure, and its subsequent maintenance. Again we are confronted with another 57 varieties. However, there are

only a few outstanding types which are in general use today and it is on these that our discussion will be centered.

A concrete pavement in a track area can be installed at a rather reasonable cost and when first laid it looks fine. However, rails have a peculiar habit of breaking, joints fall down, unless welded and then they will sometimes fail, and the concrete must then be taken up in order to make repairs. It would be a waste of time to tell you men what then happens. You know as well as I, that no concrete pavement can be satisfactorily patched, especially that along a street railway track. In addition when entire rehabilitation is necessary the salvage from the paving is nil.

Brick, wood-block and granite block are three other types of paving found in general use today. The first and third types, I am convinced, are the most efficient and give the greatest degree of satisfaction. The use of either one is governed, to a great extent, by the locality, or the convenience with which it is obtained.

Wood-block, during the past 20 years or so, has found a wide and extensive use along railway tracks, but it has also shown the greatest number of failures of the three types mentioned. Exposed to the heat of sun, and other extreme weather conditions, the binder oils will, after a few years evaporate, and then the block is ready to take up moisture, which is usually accompanied by very disastrous results. I firmly believe that many of these failures could be avoided, and the pavement given an additional lease on life if after about 5 or 6 years of service the surface was given a good spraying of creosote oil or a covering of paving pitch. This will keep the blocks and the spaces between filled with oil and prevent the infiltration of moisture.

Granite blocks, although probably the more expensive, will undoubtedly provide the best wearing surface, stand up longer along railway rails and have the largest salvage value of any type of paving in general use today.

Next to granite block I believe the most satisfactory pavement for a street railway is a good, hard burned shale brick with asphalt filler. This brick need be no thicker than 3 in. and the sand cushion no deeper than ¾ in. If laid properly and with the proper foundation, I believe such a pavement will provide the best appearing street, the most durable, give the longest life and provide the greatest salvage, excepting granite block, of any of the types in common use today on the average city property. On our large city properties, granite block, although the first cost is high, will outshine the brick pavement in practically all respects; this is due, only, to the heavier vehicular traffic, under which granite has the greater wearing power.

Asphalt has also been used to some extent, but experience has shown where laid in a track area at least one or more rows of brick or stone block should be laid next to the rails. When laid in direct contact with the rails, the tendency to heave and disintegrate is greater in the asphalt pavement than in most any other type.

Effect of Other Utlities on Track Maintenance Problems

If no other utilities occupied our streets, the street railway engineer's problem would be much simplified. The street railway, however, is only one of seven or eight utilities occupying our city streets. Some streets carry exceedingly large sewers, water pipes, telephone and telegraph cable conduits, etc. All of them have manholes at frequent intervals and to construct special track work layouts to dodge all of these openings is sometimes a pretty problem and their very presence usually causes great difficulty in properly constructing and maintaining the track and paving surface. Why, I will ask, could not the sidewalk or boulevard spaces be more generally used for the location of such utilities. Frequent inspections and repair of such utilities would then not affect the street pavement. This item may seem somewhat foreign to the street railway problem, but I assure you that such is not the case, for all too frequently ditches are cut under tracks, improperly filled, track settles, paving settles and breaks up, and the street railway is the goat.

I simply call this phase of the problem to your attention, as I believe that closer co-operation should exist between the city engineer, the railway engineers, and the engineers or managers of the other local utilities that these local aggravations may be eliminated.

LIVING WITHIN THE MUNICIPAL INCOME

By W. F. Drewry, City Manager, Petersburg, Va.

(From the *Virginia Municipal Review.*)

Balancing Receipts and Expenses.

How to spend so as to effect at least a balance between income and expenses has always been a source of anxiety to the conscientious public official who deals with the matter. In this age, which moves in giant strides, there is a tendency to spend more than we make or have to spend, in order that we may satisfy our desires, notwithstanding that we know that long continuation of spending more than is received results in financial failure. "Pay as you go" is a safe way, but following the trend of the times we often spend with too free a hand and then pay if we can.

Stretching Income to Meet Desires

I read some time ago in a standard magazine an interesting article in which my attention was especially attracted to these sentences: "The typical American psychology is anything but penurious. For many years the dominant philosophy in this country has advised not that you live within your income but that you make your income stretch to meet your desires. 'Don't knock—boost' says the typical American wall motto, don't save, spend, don't be careful, be lavish."

We hear of increasing cost of government deficits and enlarged indebtedness. This state of affairs is brought about largely by satisfying the constantly increasing desires of the people for more public improvements, more personal comforts and conveniences, more adequate means of disease prevention, enlarged facilities for education, better social advantages and higher standards generally and without these modern improvements and higher living standards we would be a retrograding instead of a progressing people.

In the very nature of things there must be either forward or backward movement. We have seen, especially in recent years, most if not all our Virginia cities and towns improve and progress, but that growth has cost considerable sums of money and human effort.

Necessity of Increase in Taxes or Curtailment of Improvements

To gratify these increasing desires we need to provide a corresponding increase in the means to meet the expenses if we would have a properly balanced account. While the people want more and more improvements and their city kept up to a higher and higher standard in every way, many of them are not keen to pay the price by way of increased taxation.

In spite of the most careful and economic expenditure of public funds, it is often impossible to stretch the revenues or income so as to meet the expenditures necessary to comply with the desires of the people. Then, as a consequence, we are confronted with the vexatious problem of either curtailing our desires and doing with less or increasing taxes, neither of which meets with popular favor.

City Manager Plan

The city manager plan, with a policy forming and legislating council and a chief executive official, was devised to insure a more business-like, economic and efficient administration of the municipal government and at the same time promote progress in the development of our cities and towns. The city manager working under the general policies adopted by the council, is charged with the chief responsibility for getting the best possible results from every tax dollar expended.

Budget

From actual experience it has been demonstrated that the budget plan of distribution and classification of expenditures of available public revenues is the wisest method yet adopted; the surest and most equitable way of adjusting the estimated expenses to the anticipated income and of regulating and controlling expenditures for definite objects in the various departments of government. The budget has been well termed the bedrock of economic administration.

The annual budget having been carefully prepared so as to meet the interest on bonded indebtedness, provide for the sinking fund and then an equitable distribution of the balance that may be available to the public schools and the various departments and bureaus of the city government, so that the total shall not exceed the anticipated income, its successful operation becomes a duty incumbent upon the city manager and his associates in the administration.

Program of Activities

It is always in the interest of public economy and good municipal management that a definite plan of contemplated permanent improvements and public work of every kind be carefully studied in advance and as accurate and detailed esti-

mate of cost as possible be made in every instance. Likewise, operating every department under a carefully worked out schedule insures more caution in expenditure and more satisfaction in results.

Excessive Personal Service

Whether the expenditure be for permanent improvements or for the usual operation of the several departments, the matter of overhead needs always to be safeguarded against excess. In the operation of the city government it is frequently in the interest of successful administration and economy to consolidate some positions and always to eliminate all employes who are not actually needed. My experience has shown this to be a wise and economic administrative policy and it has resulted in considerable reduction in the personal service accounts.

Cooperation

In order that the administrative ship may move along on an "even keel" every part of the machinery must be under constant supervision and the captain and his mates must work in harmony. Cooperation and loyal support constitute the keynote to success.

Conferences and Official Inspections

In addition to the regular formal daily, weekly and monthly reports of the various activities, the status of the budget and the condition of the finances, it is essential to have frequent individual and group and staff conferences. These meeting promote a closer relationship between the city manager and the heads of the several departments and insure much desired team work and good morale. At these conferences the several budgets are reviewed and constructive criticisms and valuable suggestions are made and considered, having for their object more economic and efficient administration in every department. The auditor or accounting official is on hand to give definite information and to sound warnings of impeding over expenditure in this or that item in the budget. Frequent visits and inspections of the various department headquarters and the city in general by the city manager, accompanied by the directors or chiefs, promote personal interest and cooperation.

Changes in Budget

Every city manager is confronted with appeals to make improvements and to authorize expenditures for one purpose or other that has not been provided for in the budget. But making alterations in the budget during the year should never be approved except under the most extraordinary circumstances, for it tends to looseness in compiling the budget and to extravagance in spending. Sometimes, however, it becomes necessary for the council to make appropriations during the year to cover unforeseen expenses.

Limiting Expenses by Months

As a safeguard against exceeding the budget allowances it is of advantage to limit expenditures as far as practicable to the month or the quarter. This is, of course, easily done in the regular routine expenses for salaries, current needs and equipment, repairs and improvements to city property. There are, however, seasons of the year when the expenses for certain supplies and additional labor necessarily are greater, such as material and repairs in connection with streets; and, also, it is sometimes an economic advantage to purchase in quantity on a favorable market in advance of the actual needs, and also there is sometimes something gained by buying by wholesale instead of by retail. I have no doubt that the proper operation of a municipal storehouse is a means of considerable saving. though I have had no experience in this respect. Over stocking and wastefulness have, I would say, to be carefully watched in maintaining a store department.

Leaks and Repairs

It is of considerable economic importance to keep a constant lookout for leaks and to see that machinery and equipment are in good working order, so as to get the maximum amount of service. Much to my regret, a too long neglected repair of some leaks at our water plant cost us a considerable sum by way of increased electric power bill and thereby embarrassing the budget for that department.

Requisitions and Purchase Orders

In making requisitions it is essential that there be as much accuracy as possible in description, quality and quantity of the article desired and a careful estimate of cost. If it is ascertained from the auditor or the bookkeeping department that sufficient funds are not available there should be a change in the purchase order if possible, so as not to encumber the budget with more than it can stand.

Emergency orders, like purchases by heads of departments instead of through a centralized agency, tend to break down a proper system of requisition orders and competitive bidding and usually incur a

loss to the city, and besides, shift and divide responsibility. Therefore this procedure should never be resorted to unless there is such urgent need that time is a most important element.

Competitive Bidding

Competitive bidding on an equitable and fair basis for what the city uses in the way of supplies and equipment not only results in considerable saving but brings about a more sympathetic relationship between the business men of the city government. Advertising for bids is often an advantage. Home merchants and dealers should be given first consideration, but when it is clear that purchasing from outside the city is to the advantage of economic administration our duty is plain.

Cash Discounts

Cash payments, with discounts, on delivery, is a means of effecting many small savings, which in the aggregate is well worth while in making efforts to live within the income.

Centralized Purchasing

Centralized purchasing has been demonstrated by both state and municipal governments to be also the means of reducing the expense accounts in the various departments. This method concentrates and fixes responsibility in one man, whose duty it is to keep informed regarding market prices, quality of material and reliable dealers.

Under an act passed by the last Legislature cities and counties may procure bids and effect purchasing through the state purchasing department. Under some circumstances, especially in the purchase of supplies or materials in very large quantities, the local government may reap a benefit by utilizing the agency the state has made available.

Conclusion

Notwithstanding my conviction that in the conduct of the business affairs of our cities the strictest economy consistent with efficient public service should prevail, I stand for the spirit of material progress in which we should heartily unite in making Virginia a still greater and more prosperous state.

BETTER ACCOUNTING AND BUSINESS METHODS FOR CONTRACTORS

By William Joshua Barney.

(Address delivered at Eighth Annual Meeting, Associated General Contractors of America, Asheville, N. C., January, 1927.)

There certainly are gathered here the brains, force and leadership of the Great Empire of the Construction Industry. For me to address such a gathering as this is truly "carrying coals to Newcastle." My warranty for speech lies not in the hope of presenting new ideas, but rather in reviewing and discussing some of our serious problems, so as to form the basis for their solution. My faith in the soundness and steady advancement of our great industry is unbounded. On the other hand, all progress and improvement frequently require a critical review of existing conditions, not with the idea of self-praise and congratulatory platitudes, but rather a severe self-examination for weaknesses, inequalities and inefficiencies. It is only by such a frank check that we can, from time to time, determine the intelligent cooperation needed to guide our industry forward and upward.

Let us look at the financial side of our work. Despite the engineer's time-worn statement that he has never known a contractor to admit making money on a job, there are undoubtedly many contractors of large wealth throughout the country. These are only the imposing figures in the foreground of the picture which naturally catch our eye. Behind them are countless thousands of contractors struggling in the morass of unprofitable conditions. The true significance of this picture is fully illuminated by the government income tax returns for the one year in which they were made public. These records show that the contractors of the United States as a whole made less than 1¾ per cent profit after deduction of Federal and State taxes alone, without taking into consideration interest on paid-in capital. In other words, on $1,000,000.00 worth of work, there was only an average profit of $17,500.00. No wonder the average banker fights shy of the contractor's account. In fact, to my mind, one of the greatest tributes to the high personal integrity and moral soundness of the contractors of today lies in the credit extended to them by the financial interests of the country. But will any thinking man claim, in the face of these figures, that contracting is on a sound basis or that the contractor makes a sufficient profit? Why, I ask you, is contracting found in such a precarious condition? There are many answers to

this complex question, each of which is fraught with valuable suggestions for intelligent cooperative effort.

Perhaps aside from the farmer, we contractors are the most individualistic and singular type of business man. In accordance with age-long traditions, each contractor learns his business in the hard school of personal experience, practically never interchanging information or cooperation with his competitors, each rising and falling on his own individual judgment, his own peculiar experience. Until very recently, only here and there, have contractors made a few feeble attempts to gather together in social and business intercourse. Little, if any, literature or printed data were available to guide the new entrant in the field. Young architect, your engineer, your banker, your lawyer, for years—in fact, for generations—have had their great national organizations, have developed great libraries of information and have had available the most thorough and special courses in colleges and universities. Only in the last few years, through this organization now functioning so splendidly, has the contractor had a national body to further and protect his interests, to enlighten him on the latest practices and methods. The very youth of this organization gives proof of how backward in modern business methods and business ways we contractors have been as a whole.

More striking still is the fact that only within the last year have two of our great universities created special courses in the building construction. In my day and your day the contractor, seeking an education, was compelled to take a course embracing practically all known branches of engineering, a dabble of civil engineering, a dash of hydraulics, a pinch of electrical, to say nothing of railroading and dam building. After graduation, he could then start in to pick up here, there and everywhere, disjointed bits of information about his life's work, having from his technical training the effective use of the slide rule and a knowing expression when "shear and tension" were spoken of. Far be it from me to decry the unquestioned advantages of a thorough education and mental training, but I think it is a very hopeful sign of the times that two great universities — Yale and Boston Tech—now offer a course on building construction to the future contractor where at least one, if not two years, of his time will be concentrated on learning the technical fundamentals of his own work.

All this is to say that the contractor in the past, and even today, in many sections of the country, is too individualistic. He must develop a closer social and business relation with his fellow-workers in the same field, be perfectly willing to give information, data and experiences in order to receive like benefits from others. In each community center the active and forceful contractor must be willing to give some of his time in gathering together his competitors for regular interchange of technical and business information and methods, to cultivate social gatherings, at which he and his fellow-contractors will come to know each other as men and develop that mutual confidence and trust that comes with such knowledge.

We must not rely on the formal framework of our national organization, nor trust to being pushed and led from above, but be willing to go back to our own community and start at once the contractor's get-together spirit and movement.

Perhaps you will think that I have wandered a long way from the original query as to why contractors do not operate on a sounder profit basis, so let us look for a few minutes at some of the more specific symptoms or causes. As to much of what I am about to say, you will undoubtedly have the reaction that I am speaking to the wrong group of men, that my suggestion should be addressed to those who are not fortunate enough to be members of the A. G. C., or more especially, to those who are not sufficiently conscious of their leadership responsibilities to be in attendance at this convention. On the contrary, it is before the leaders of the industry that criticism should be laid for their consideration, refutation or remedial measures. Unquestionably, small profits and great hazards in our business come largely from inadequate cost data and lack of sound methods and principles for complete estimating.

The fact that we are doers of deeds, not writers or philosophers, makes us impatient with red tape and paper work. Our timekeepers are generally regarded as handy men on the work, to check up the fact that the mechanics and laborers are actually on the job and entitled to run errands here and there for superintendents, to fill in their time with running lines and levels and other special

work. We are loath to spend steadily for for the employment of real cost clerks, for men whose time shall be devoted exclusively to analyzing the day-by-day cost, of summarizing these weekly and presenting their result in figures that will either show blue or red for each and every item of the contract. And even where this cost data is kept, there is a marvelous diversity of methods and results, even between individual contracts of the same organization.

We can not hope for sound prices on our work or the foundation of real profit until all contractors throughout the country realize that accounting is of the same value to them as it is to the manufacturer, the banker, the department store and every other branch of business activity. Moreover, must especially be realized the necessity for current and immediate use of such data, that it must not be allowed to accumulate in the record room or desk drawers of an estimating department, but be sure that current estimates and proposals are based upon current conditions. In fact, cost data a year old is more dangerous than none at all under the constantly changing conditions of today in respect to the price of materials and the demands of labor.

But if the neglect of cost data causes inquiry as to the intelligence of many in our industry, what is the impression left when we examine the estimating methods and forms of many contractors? True, even the crudest estimate will generally show an attempt to break down certain fundamental items into the direct cost of labor and materials, sometimes with allowances for the more striking items of general job expense, such as plant installation, trucking, tools and supplies, etc. In respect to these latter items, too many contractors are prone to leave them out in part of whole or to make some arbitrary percentage allowance. But how many contractors' forms show a specific place for such items as bad weather, cutting and repairs, protection of work, demurrage, plant rental, photographs, plans, and more especially for interest on investment, interest on loans, depreciation on plant equipment, credit for discounts—items that in practically all other forms of commerce have long ago been established as fundamental in the cost of doing business? How many contractors know what percentage on their normal volume of work constitutes a proper allowance for their general expense—office rent, executives' salaries, sales expenses, etc.? I am sure that practically no contractor figures into the cost of his business his bad accounts—an established item in the overhead charges of any successful departmental or mail order house. It is these "invisible items" that eat into the profits and make so low the final returns on the contractor's investment or the capital stock of a construction company.

Of course it is true that many of us—I presume all of us here today—are up-to-date enough in our estimating methods to at least recognize many of these items of cost and perhaps to take care of a large part of them in estimating work; perhaps have a very different knowledge of what is the minimum profit that can be placed on a contract proposal to meet the general expenses of our business. But under present conditions, the more intelligent we are in these respects, the rougher and the harder is our road of completion. The other fellow goes on year after year, blissfully ignoring these sound principles, or perhaps I should not say "the other fellow," but a succession of "other fellows"—each in turn wondering why contracting has not paid him handsomely, why, after years of struggle, he finds himself slowly but surely sinking in the mire of diminishing capital and lessening income. Therefore, we should give all enthusiasm, all support, all energy and not a small amount of our own personal time to backing up the work of this association, in spreading abroad throughout the country these fundamental principles of cost keeping and estimating among our fellow-contractors, and insisting upon their including in their proposals allowances to cover their full cost. Until we have a widespread, universal acceptance of these fundamentals, we can not hope for any general idea of prosperity among contractors and builders.

Then, there is another phase. In our trembling anxiety to close the contract and to avoid giving offense, we are very prone to pass over any questions as to the real financial soundness of the man with whom we are going to do business. Perhaps by our attitude we have invited the strange psychology, seemingly so prevalent that contractors are a curious breed of business men to whom it is not necessary to explain the financial details or soundness of an undertaking—a psychology, in fact, that any questions by the contractor are impertinent and irrelevant, his position being to thank-

fully accept the contract, to become so thoroughly financially involved in its performance as to be grateful for payments on account, to say nothing of accepting obviously unjust deductions to get his final payment.

Your department store, even your corner grocer, before sending you goods on credit, asks for your financial references and as to your habits in paying bills. And it is this latter question that is really most important—what are a man's habits in respect to his obligations?—a factor that is rated more highly by banks than a man's actual cash assets, only they call it by the more high-sounding title of "moral risk." And, it is this element of "moral risk" that the average contractor is apt to overlook, even where he has made some inquiries as to the financial standing of a prospective client. Many a contract, apparently entered into upon a profitable basis, has turned out to be a losing venture because the owner procrastinates, defers and finally wears out the contractor, so that he accepts unjust and liberal deductions from his final payment in order to get his money and be free to devote his energies to some newer undertaking.

THE MASTERY OF THE OHIO RIVER

By Edmund L. Daley, Major, Corps of Engineers, U. S. Army.

(From *The Military Engineer* for May-June, 1927.)

The story of the century-long struggle for year around navigation on the Ohio River is a history of achievement. From the crudest beginnings and small expenditures, to extensive engineer operations and allotments of millions of dollars, a hundred years of snagging and dredging, of diking and cut-offs, of movable dams and fixed dams, have seen a steady growth in the positive control of this mighty river. The battle between man and nature will never be finished. The Ohio is a mettlesome steed, sturdy for service, but active, restive, and ever liable to bolt. Prophetic vision, engineering courage, and daring persistency are bringing the river into control. Constant vigilance will assure the continued service of this mighty water route.

The Ohio River is one of the largest tributaries of the Mississippi River, the only large one emptying from the eastern side. It is formed at its head at Pittsburgh, Pennsylvania, by the Allegheny and Monongahela Rivers, both important navigable streams. Into the Ohio along its route flow such important tributaries as the Muskingum, Great Kanawha, Big Sandy, Kentucky, Wabash, Cumberland, and Tennessee Rivers. The river's length from Pittsburgh to Cairo, Illinois, is 968.5 miles. The drainage area is 203,900 square miles. The low- and high-water discharges at the head are estimated at 1,600 second feet and 440,000 second feet, respectively, and at the mouth 27,500 second feet and 1,500,000 cu. ft. per second. The average fall on the first 30 miles at the head is 16½ in. per mile, and the average fall for 500 miles from Cincinnati to the mouth is approximately 4 in. per mile. Its width varies from 890 ft. at a point 105 miles below the head, to 5,910 ft. at a point 22 miles above the mouth. The Ohio differs from other large rivers in that its width is fairly constant in the 300 miles below Pittsburgh. Below Cincinnati, the stream widens rapidly.

While important freshets may occur at any time of the year, the higher floods occur almost without exception during the latter half of the winter. Maximum floods do not always involve the entire river. For instance, the highest recorded stage at Pittsburgh was 35.5 ft. in 1907; at Cincinnati, 71.1 ft. in 1884; and at Cairo, 55.8 ft. in 1913. The low-water stage ordinarily prevails from July to November, inclusive.

In its natural open-river condition, extreme low water reached a depth of 1 ft. at the head and 2 ft. near the mouth. Such unnavigable stages frequently continued for long periods. Before any considerable part of the river had been slack-watered, the existing commerce accommodated itself to the intermittent navigable stages produced by flood waters. The large Pittsburgh coal fleets were assembled there, held in readiness for the socalled barge or coal boat stages, approximately 8 and 10 ft., respectively. These waits continued sometimes as long as six months. Such unpredictable delays prevented successful commercial navigation. Water transportation must be continuous and dependable to be an economical and valuable assets. Attention was, therefore, early turned to the desirability of improvement. In the eighteenth century, Washington, the engineer and cartographer, was impressed,

in his explorations, with the possibilities of the Ohio system for the navigation of his day.

The legislatures of Kentucky and Ohio, early in the nineteenth cestury, interested themselves in the improvement of the Ohio. By act approved May 24, 1924, Congress made its first appropriation of $75,000 for improving the Ohio. President Madison reported in his annual message, December 7, 1824, "the superintendence of them had been assigned to Officers of the Corps of Engineers." This was the inception of an engineering task which has made its own precedents.

The earliest improvements on the Ohio River were regulatory, first consisting of the removal of snag, bowdler, and bar obstructions, and the construction of cut-off dams closing secondary channels at bars and islands, and of longitudinal dikes concentrating the water flow on shoals. These structures were orginally crude, built of large rough stones. Subsequent to 1875, heavy crib work was introduced and wing dams and dikes were carefully filled and paved with stone. Coincident with these open-channel improvements, systematic channel dredging also was performed. These improvements were helpful, adding to the safety of navigation, and a few days to the navigable periods or seasons. But the Ohio was not yet a continuous, dependable all-the-year waterway.

Some fifty years ago, a slackwater system was decided upon as the only dependable method for providing a comparatively continuous navigation on the Ohio River. A fairly substantial river bed of gravel or sand, overlying a rock bed, relatively high and substantial banks, and reasonably narrow widths over the greater part of the stream, assured the practicability of lock and dam construction. A most difficult question for determination in connection with the slackwater improvement of the Ohio River was the type of dam to be used. As a general principle, we now hold that fixed dams are preferable to any design of movable dam, wherever practicable. However, in 1870, there existed opposition to any system of dams which obstructed the river during the relatively long seasons of open-river stages navigable for the transportation of the large coal fleets over the full length of the stream. The old pilots would not listen to proposals for fixed dams.

A thorough study of the systems of movable dams in France was made by Colonel William E. Merrill, Corps of Engineers. Colonel Merrill, in 1874, while in charge of the Ohio River improvements, recommended the chanoine wicket dam as the only suitable one for so large a stream, and proposed that one such structure be erected 4½ miles below Pittsburgh to afford a 6-ft. stage in the Pittsburgh harbor. He further recommended that, if this dam were a success, twelve additional structures of the same design be constructed between it known as Number 1, and Wheeling, West Virginia. Even the proposition for a movable dam met with the sternest opposition from the Pittsburgh coal interests, with the single exception of Captain John A. Wood, leading coal shipper at Pittsburgh, who courageously advocated the construction of such an experimental dam. As a concession, a large lock 110 ft. by 600 ft., capable of passing 10,000 tons of bulk commodities at one time, was doubtless an important factor in securing assent of the shippers to this important experiment.

The structure was authorized by the River and Harbor Act of March 3, 1879. Thus began the first halting step in the Ohio River slackwater development. More than thirty years elapsed before the adoption of a comprehensive project for improvement of the entire river by means of locks and dams. Lock and Dam Number 1 were completed in 1885. The navigators were partly converted and the construction of Dam Number 6 was authorized in 1890. Authorization followed for Numbers 2, 3, 4, and 5 in 1896; for Numbers 13 and 18 in 1899; for Numbers 8, 11, 19, and 37 in 1902; and for Number 26 in 1907. In the meantime, Dam Number 41 at the head of the falls at Louisville was constructed out of the indefinite appropriation for "Operating and Care of Canals, etc."

However, there was not yet any comprehensive project, although the authorization of these widely separated structures in a measure had committed Congress to the slackwater improvement of the Ohio River, at least from its head to the falls at Louisville, 600 miles away. Each dam constructed added to the length of the navigations periods in the affected parts of the river, and continuous navigation for the upper half of the stream was approaching the predictable.

The earlier dams, Numbers 1 to 6, inclusive, were designed and wholly or in part constructed to provide for a navigation depth of only 6 ft. About 1904,

with Numbers 1 to 6 completed, and Numbers 2, 3, 4, and 5 partly built, navigators, now converted to slackwater navigation, suddenly awakened to the fact that a 6-ft. navigation would not meet their needs. The coal barges had minimum drafts of 6½ ft., and a maximum of 8½ ft. Nine feet was determined to be the minimum economical depth necessary for the conduct of the Ohio River navigation as it then existed.

While Congress was, in a sense, committed by its acts to the partial improvement of the upper half of the Ohio River, the commitment was not whole-hearted. Any effort to secure an increase to a 9-ft. project might result adversely to the works already authorized. The issue was placed before Congress. In 1905 that body authorized the extension of the Pittsburgh harbor to Beaver, and a change of the uppermost five structures from 6- to 9-ft. depth. This important decision was followed by the important and logical action of Congress in authorizing a survey of the entire Ohio River, with a view to its improvement by means of locks and dams. The Lockwood Board was appointed to make this survey and its work was completed, and report was made to Congress. By the River and Harbor Act of June 25, 1910, Congress adopted a project providing for fifty-four locks and movable dams with a 9-ft. depth for navigation.

Under discretionary authority given the Secretary of War, modifications have since been made. Lock and Dam Number 42 have been eliminated by adjusting the lifts of Dams Numbers 43, 44, 45, and 46. Dams Numbers 1 and 2 were eliminated and removed after the construction of the fixed dam at Emsworth. Dam 40 has been eliminated from the project by rebuilding Dam 41 as a power navigation dam with increased lift to provide the project depth to the lock at Dam 39. Numbers 3 and 4, in the Pittsburgh District, are being eliminated and will be removed as soon as the new fixed dam at Deadman Island has been completed to replace them.

There are several important reasons for the change from movable to fixed dams at Emsworth, 6 miles, and Deadman Island, 13.6 miles, from the head of the Ohio River. First, the steep slope of nearly 1½ ft. per mile in the upper reach made it impracticable to maintain the 9-ft. navigable depth at all times; second, the importance of the Pittsburgh harbor from the industrial and navigation viewpoint rendered a fixed pool necessary; third, only by means of a fixed pool at Pittsburgh can the steep slope at the mouth of the Allegheny River be rendered satisfactory for the convenience and safety of navigation passing into and out of that river; fourth, having been originally constructed for a 6-ft. navigation, and then changed to provide a 9-ft. depth, Dams 1 and 2 were deteriorating so rapidly as to require early reconstruction. This led to the construction of the fixed dam at Emsworth. Replacement by a fixed dam reduced the maintenance and operation cost materially. The necessity for drowning out a 9-ft. fall in 2 miles above movable Dam Number 3 is the principal argument in favor of the second fixed dam. Deadman Island dam is under construction. Ultimately, it may prove wise to extend the fixed dams to a point below the Beaver River, where flatter slopes and more water will assure the 9-ft. stage in the transition periods when the river is falling and dams must be raised. A third site is being investigated for a fixed dam near Beaver Shoals. This would eliminate movable Dams 5 and 6.

Necessarily, the type of dam to be adopted is the first controlling factor as to location. If the improvement is to consist of movable dams, each structure must give consideration to the condition when the dam next below it is down at low water. Eighteen feet being about the maximum vertical height for chanoine wicket dams, the requirement of a 9-ft. navigation will permit only about 9-ft. maximum lifts for this type of dam. The average lift, excluding Dam No. 41 at Louisville Falls, is about 8 ft. Fixed dams, if height of banks will permit, will yield from 12- to 20-ft. lifts, and will locate the structures much farther apart. If movable crests be added on top of fixed dams, distances between structures may be still further increased. Formerly, one of the principal considerations in the location of a lock and dam was foundation conditions, a rock foundation being selected if at all available. Character of foundation is now made a secondary consideration.

The principal factors to be considered in the general solution of locating locks and dams are: First, height of banks at, and upstream from, the proposed structure, and character and value of bottomland improvements above dam (this is a question of damage resulting from submergence); second, long straight-line

reaches are sought to permit easy approach and departure from the lock in either direction with large tows; third, for fixed dams only, the greatest possible width of spillway in order to reduce back-water heights, and especially flood effects by affording maximum spillway capacity fourth, a lock location such as will obviate interference with the existing running channel during construction of this major structure. During construction of dams, navigation passes through the lock. For the location of locks with movable dams, the first and third of these considerations may be disregarded, the important considerations being long straight reach and minimum interference with running channel during construction. In such a large stream, preference will be given to movable as against fixed dams if the banks are so low as to be frequently inundated; if there is a natural navigation stage adequate for commercial purposes during the greater part of the year, and if it is desirable to conduct the navigation in large fleets during the stages when the river would be navigable in its natural condition without creation of pools.

The dimensions of locks will depend first on the limitations of low water that effect the supply of water for lockages purposes; second, on the character of commerce; third, on the probable extent of the commerce. If many years are estimated as necessary to develop an extensive commerce, it may be more economical first to build the small locks or single lock and, when necessary, add a duplicate chamber or enlarge existing chambers, or both; and, fourth, the size of the maximum fleets ordinarily transported.

On the Monongahela River, the lowermost six locks have two chambers, each 56 ft. by 360 ft. Original locks were 50 ft. by 160 ft. The coal fleets are ordinarily made up of a steamboat and six or seven barges, 26 ft. by 175 ft., which are passed in two lockages. On the Allegheny River, with a smaller tonnage, single-chamber locks of somewhat shorter length were constructed as Dams 1, 2, and 3. Now, with a 5,000,000-ton annual commerce, new locks above Number 3 are being built to the Monongahela River standard—56 ft. by 360 ft. It is probable that in the near future a second unit of this, or a larger, dimension will be added at the lowermost dam on this river. At new Numbers 7 and 8, Monongahela River, a single chamber has just been completed which is so designed as to permit adding a duplicate chamber when, and if, the growth of commerce requires it.

On the Ohio River, the situation was different. Owing to the longer distance traversed, it is desirable to transport large fleets of barges, some of which are shipped all the way from Pittsburgh to the Mississippi River, down the latter to Memphis, Vicksburg, and New Orleans. To meet this requirement, the locks are uniformly 110 ft. by 600 ft., irrespective of the amount or general character of commerce in local reaches. At the Emsworth fixed dam, which forms the Pittsburgh pool, a second or relief lock, 56 ft. by 360 ft., has been added. With a fixed dam, double locks are a necessity to care for emergencies since there is no navigation over the dam.

Sill depths depend first on the stream conditions to which navigation must necessarily conform. On the Ohio, Allegheny, and Monongahela Rivers, these conditions are sufficient for a 9-ft. depth of navigation. There should be more water over the lock sill than the controlling navigable depth on the reaches between dams. The slackwater system on the Ohio River now consists almost entirely of movable dams with single locks 110 ft. by 600 ft., designed as a 9-ft. project.

For a long time, the lock-and-dam improvement of the Ohio River progressed without definite plan, depending almost entirely upon the appropriations made by Congress for the various localities. This policy resulted in the completion of Lock and Dam Number 1, in 1885; Number 6, in 1904; Number 2, in 1906; Numbers 3, 4, and 5, in 1908; Number 18, in 1910; Numbers 8, 11, 13, and 37, in 1911; and Number 26, in 1912. About the latter year, a definite policy was adopted to construct, beginning upstream, alternate dams in order at least to furnish moderate navigation depth down to the Louisville Falls as quickly as possible, and to satisfy at the earliest time the various interests along the entire river. Under this policy, the even-numbered dams were built first. Thus, the structures have now been completed from the head of the river at Pittsburgh to, and including, Number 41 at the Louisville Falls, 600 miles away, and Numbers 43, 44, and 48 below the Falls. All of the remaining structures have been commenced, and their completion by 1929 is contemplated.

It has been the general belief that the construction of locks and dams is much more difficult than their subsequent maintenance, including operation and enlargements where necessary. This, however, especially where a large growing commerce exists, is not the case. In the construction of new locks and dams, the builder is little concerned with navigation, except for a few days when it is transferred from the open channel to the new lock. Accordingly, the weather and water conditions are his main concern, and the performance of any part of the work at a definite time is ordinarily unnecessary. On the other hand, repair work and the enlargement of locks, dams, guide walls, and channels must be performed in the shortest possible time, regardless of weather and water conditions to a large extent, and in such manner as to keep navigation moving and cause the least possible interference with it.

Breakages where they interfere with navigation are frequent and often unexpected. Plant, repair forces, and materials must be rushed to the structure and the repairs made with all speed. In new construction work, builders usually perform their work in a large, well-established cofferdam with a thoroughly efficient plant, advantageously placed. Important repairs must, however, be made with all of these important factors reduced to the minimum. When ice conditions become serious, the builder suspends operations, although navigation continues with the rivers partly frozen, and the operation and repair work, though more arduous and dangerous, must be kept going. While true of all locks and dams in a northerly clime, this is particularly true of the maintenance and operation of the movable-dam system on the Ohio River. Repairs to movable dams and beartraps are normally made in summer while the dams are up. Divers are employed to make the underwater adjustments. Repairs to locks of a movable system are made in winter, when the dams are down and the locks not needed because of sufficient natural depths for open-river navigation.

The operation of the movable dam system is analogous to the operation of a railroad division. Tonnage must be passed over a definite reach of river in dependable manner. The river is divided into districts and subdistricts. Each dam is manned by permanent operating personnel. The endeavor is made to keep pool stages stable. Local rains and small rises are controlled by lowering one or more beartraps, and a few or more wickets. Large run-offs require the lowering of the dams. This is a difficult and comparatively dangerous operation often performed under the hazards of darkness, rain, cold, ice, swift currents, and drift. The reverse operation of raising the dams is a more deliberate and less exciting task. Assured navigation requires trained personnel of high morale. In the space of thirty months, in the Pittsburgh District, one packet reported having made over 6,000 lockages with a total delay of but twenty-two hours from causes attributable to operating defects. Such results require alert attention to the river, the weather, and the structures.

The important problems of the upper river are those incident to operation of the existing structure to assure continuous, dependable, year-round navigation. The increasing commerce makes demands on the operating machinery which require constant attention and prompt repair. The assaults of nature against the structure create damage that must be repaired. Fair wear and tear, and normal deterioration, tend to lower the usefulness of existing structures. All upkeep and reconstruction work must be planned and executed so as not to interfere materially with navigation. The slackwater navigation, combined with the periods of open-river navigation, with lowered dams, now assures practically 355 days of 9-ft. or better, navigation each year, all the way from Pittsburgh to Louisville.

In the Pittsburgh District, the construction at Deadman Island of the second fixed dam will assure better stages in the transition stage from open-river to pool navigation. The passage from the fixed-dam system to open-river navigation now takes place below Emsworth lock in a very steep stretch of the river. The elimination of Numbers 3 and 4 movable dams by the Deadman Island fixed dam will move the transition stage from the fixed-dam system to open-river navigation into a flatter stretch of the Ohio. Because of the steep slope on the stretch below Emsworth, the run-off on a falling river was so rapid that the navigable depth between Emsworth fixed dam and Number 3, movable dam next below, was sometimes not more than 4 ft. during the period of raising the dam. Sometimes, two days after starting to raise the dam were needed to rebuild the

pool from a 4- to 9-ft. stage. With a second fixed dam below, these conditions will be less severe. Hours instead of days will be required to build up Pool 5 from 6 or 7 ft. to a 9-ft. stage. A third fixed dam near the mouth of the Beaver River would make possible a practically continuous 9-ft. stage, despite lowering and raising of dams. Investigation of the needs and possibilities for such a third fixed dam is in progress.

From Pittsburgh to Louisville, there is a tried and adequate canalization system. Constant attention is required to maintain efficient operation under the handicap imposed by weather, flood, drift, ice, and low water. The system is surmounting these obstacles and the assurance of dependable navigation is resulting in a steady growth in waterborne commerce. The Upper Ohio improvements are an economic success.

Between Louisville and Cairo there are still gaps in the slackwater project. The immediate goal is in sight, as every lock and dam is now under construction. By the end of 1929, the Ohio should be completely canalized. The problems of the lower river include the operation of complete locks and dams, but the task of the Louisville District is predominantly construction.

The problems to be met include the detailed design of dams, weirs, beartraps, locks, lock gates, valves, and operating machinery. The works are being constructed, as in the upper river, either by contract or by hired labor, dependent on which method is to the advantage of the United States, or is required by the exigencies of the situation. In some cases, difficulties of construction and hazard of the river are such as to have eliminated any competitive bidding for the construction of the locks and dams. At these places, the Engineer Department is carrying on the work. At other places responsible contractors are building the new works.

Large amounts of land and floating plant are required for operation and maintenance, and for construction or reconstruction. Dredges, both dipper and hydraulic, derrick boats, mixer boats, pump boats, barges and scows, pile-drivers, scraper boats, and tow boats are needed in large number. In addition, there are employed in the work many items of land plant, small tools, and construction material. Besides the permanent forces manning the locks and dams, and the pieces of floating plant in commission, reconstruction and emergency repair crews must be maintained, skilled in the unwatering of locks, gates, gate recesses, valves, and bearings. Each district employs divers, since much of the investigation and many of the repairs are under-water tasks.

In addition to the task of improving navigation by controlling the natural forces and the wild traits of the river, Congress, by an act approved March 23, 1906, has entrusted to the Corps of Engineers the duty of protecting the navigability of the river from the acts of man. No bridge may be constructed across the river until the plans thereof have been approved by the Secretary of War and the Chief of Engineers. Furthermore, by the River and Harbor Act of March 3, 1899, no dam, dike or causeway, wharf, pier, dolphin, boom, weir, bulkhead, or other structure, may be built over the river except on plans recommended by the Chief of Engineers and authorized by the Secretary of War. An important duty of district engineers in charge of the Ohio River is to prevent the unlawful deposit of refuse or material of any kind on the bank, or over the bank, of the river where it is liable to be washed into this navigable stream. Constant patrolling and unceasing vigilance are necessary to prevent these acts detrimental to navigation.

The furthering of the interests of navigation is complete on the Ohio River. No pipe can be buried in its bed, no bridge or wire crossing may be placed above its water, no structure may be built on its banks except by authority of the War Department acting through the Corps of Engineers. No sand or gravel or other material may be removed from its bed, nor can refuse or other matter be placed within the limits of the flood cross-section except by authority of the Secretary of War.

Finally, the river itself has been harnessed and the benefits of this broad water highway have been extended from a few, irregular periods each year to a twelve-month service in the interests of navigation. The locks and dams built under the direction of the Corps of Engineers have assured the year-round, dependable navigation of this great river.

The system is about to operate as a through route. Growing commerce will require still more repair and reconstruction works. Each large shipping center, as its importance as a river terminal becomes greater, will demand that con-

sideration be given to the advisability of creating a fixed pool by substituting a fixed dam for the movable dams whose varying levels are unfavorable to the navigation interests as well as to the other large users of the river water.

Since Colonel Merrill had his vision of a canalized river, the Ohio has been a workship and a training school for officers of the Corps of Engineers. A great deal of vision and pioneering in river construction have assured the successful conclusion of the construction phase of this problem. The phases of reconstruction, and maintenance and operation, will become relatively more important with the increasing commerce. Inventiveness and originality have marked the development of the mechanical features of the gates, valves, and power equipment.

STREET LIGHTING AT SAN JOSE, CALIF.

By W. L. Popp, City Engineer, San Jose, Calif.

(From "Pacific Municipalities" for May, 1927.)

If we can believe that a man is known by the company he keeps, or by the clothes he wears, we have good reason to believe that a city is judged by the illumination of its streets and boulevards. This, I believe, is especially true of the main business streets and routes of through traffic. From the dignified advertising quality expressed by the sparkling crystal "life" of light, with the inestimable important factor of safety to life and property, the ease and comfort to operators of vehicles, the guidance to strangers in keeping on main arteries, to the unlimited possibilities for the development of artistic means of supporting lighting units, no other problem of city service perhaps offers such an interesting study.

It was with a realization of the importance of these and other features that the City Council, the City Planning Commission and the Engineering Department of the City of San Jose cooperated fully in the establishmnet of a proposed new street lighting system of which the first units have just been completed. Although San Jose is by no means the first city to discard the obsolete "Cluster" electroliers which were at their time of installation such a sign of progressive civic development, it perhaps has embarked upon the installation of as modern a street lighting system as can be found in the country. This was made possible to some extent by taking advantage of the success and failures of details of earlier installations of modern street lighting.

To begin with, the Council, City Manager and the City Planning Commission determined that before any block of lighting be considered, a standard post and lighting scheme be developed which would preclude the possibility of haphazard lighting or non-conforming units on different streets and in different sections of the city. Accordingly the City Planning Commission and the Engineering Department developed a "Family" of lighting standards which would be properly designed for illumination, structurally correct, easy to maintain, accommodate the future development of lighting equipment, and in addition be an artistic credit to the city.

The most unique feature is that the standards as provided are a distinct "San Jose" standard for the entire city. The City Planning Commission employed a local designer to incorporate its and the Engineering Department's ideas into a post of architectural beauty. Many cities have done this for certain streets but San Jose adopted a uniform system, when it designed its "family" of standards. It was realized that no amount of study could determine the character of a street frontage development any number of years in advance. It was found that three posts would be necessary to cover the field of lighting namely, intensive uptown business, secondary business, and residential lighting.

For flexibility and economy the same post is used for uptown and secondary business. The post when used for the former supports a double branching casting for the duplex lighting units, and for the latter a single collar-like casting supporting a single lighting fixture is used.

Accordingly a secondary business street which may later develop into an uptown business street can change the standards to the duplex lighting by the addition of a sectional casting and an additional lighting unit without the loss or scrapping of the initial installation. The post (being the same for both types) has sufficient room for the installation of the larger transformers. The parts of the old equipment inside the posts not usable can all be salvaged for other semi-business lighting projects. The residential standard is a complete post smaller than the other. However, all

designs were made so that correct proportions were obtained and further that the smaller post has the same architectural treatment.

The duplex standards are 18½ feet to light centers, the semi-business 15 feet and the residential 12 feet. The bases of the larger posts are 22 inches square and although tapering in slightly have a so-called "high base," with a dimension of 17 inches 2 feet above sidewalk. This provides maximum room for electrical equipment without submerging same into concrete piers but a short distance, thereby securing accessibility. All business standards are designed with lugs and bolts near the top to take the specified three inch galvanized steel pipe which is imbedded in the concrete foundations. This is a safety feature to protect the public from a falling portion in case a very great blow is given a pole tending to snap and break the upper parts away from their supports.

After the drawings for the posts were submitted by the City Planning Commission and adopted by the City Council, the Engineering Department designed a preliminary key map spacing and locating all proposed electrolier installations in the business, and semi-business districts, and on major traffic boulevards. This was submitted to the power company in order that through the cooperation of the City and Company Engineers study and arrangement could be made so that each individual job would dovetail into a master plan, thus assuring proper and economical sizes of conductor, conduit, and distributing transformers, etc. By means of the map all parties concerned could "look ahead" in determining underground work, electrical manhole installations, etc.

It can be stated here that the greatest difficulty experienced was in appeasing the impatience of the progressive property owners fronting on the first two jobs until the above described plan of electroliers for the entire district could be developed. However, as soon as the Engineering Department had the plans ready, proceedings were started under the provisions of The 1911 Act and installations were first lighted on Armistice Day. The greatest satisfaction was expressed by all, and the brilliance and quality of lighting was greater than any of the owners had anticipated. Although greater lighting intensities are obtained in larger cities, few if any, have the uniformity of light and absence of glare as given by these installations. Spacing of our electroliers range from 100 feet to 135 feet, according to street width, candle power of lights used, and other controlling illumination engineering factors. However, modifications of spacing must be made in order not to block permanent driveways, cellar doors, etc., although the removal of smaller obstacles is called for in our plans. A check by means of a photometer was made to prove up on theoretical figures for maximum, minimum and average candle power determined to be delivered per square foot of street surface. This was made on both rainy and clear nights (due to variance of pavement absorption of light) and very satisfactory results obtained. Minimum was .45, maximum .65, and average .6 foot candles showing that minimum was obtained only over a small proportion of surface such as directly under posts, etc. Auto drivers are surprised for when they drive along lighted area they can barely notice difference when their headlights are turned off. In fact there is such an even lighting that small objects are seen with ease and without the strain accompanying the glaring path of light furnished by headlights. Proper street lighting is almost indirect lighting to the motorists. To prove the popularity of these electroliers approximately 30 blocks of uptown business property has petitioned for lights, since seeing the 6 blocks initially lighted. All posts are of cast iron and being of city design allow for open competition on all jobs. The lighting units selected were the Westinghouse Paragon type of unit and petitions received called for the Westinghouse equipment which is approved. To date all jobs have been ordered under the so-called petition system. Forms for petitions must be obtained from the Engineering Department. Estimated unit costs, front foot costs, and all necessary data is given over the Engineer's signature, thus assuring property owners, "who first read what they sign," that there can be no misrepresentation by solicitors as to the costs.

Within practical limits all property owners are assured of equal lighting service (taking into consideration the three types hereinbefore explained) as spacing and intensity of lamps are determined to give equal candle power per square foot. For example, for uptown business not less than .5 foot candles. Finally, a small but important fact, with regard to our standards, is worth stating. All the post castings provide hold-

ers for street name, traffic signs and decorating flags, etc. In addition to the splendid cooperation given by the officials and engineers of the Pacific Gas & Electric Company a great aid has been furnished by the illuminating engineers of the company furnishing the equipment. This was offered by all competing companies. Many valuable suggestions and engineering data were furnished by their engineers as demonstrated by the finished installation and final test. The field of street lighting offers great possibilities and it is hoped that other cities will furnish data and ideas which will aid in procuring flexibility and economy of change to conform to the development of our rapidly growing western communities.

CITY MANAGER PLAN—A REVIEW AND SUMMARY

By Maurice Early, Political Writer, Indianapolis Star.

(Editor's Note: Mr. Early, a widely-known Indiana political writer, recently wrote a series of articles on the commission-manager form of municipal government for his newspaper, the Indianapolis Star, after investigating the workings of the plan in Cincinnati, Kansas City, Cleveland, Dayton, Grand Rapids and Kalamazoo, Mich., and Michigan City, Ind. The following article, reproduced from the "Star," gives a review and summary of his entire investigation. He wrote from the unbiased viewpoint of the student and his articles have been highly appreciated throughout Indiana and should be of value to students of municipal government throughout the country.)

Actual operation of the manager plan of municipal government in seven representative cities of the country which has been reviewed in The Star after first-hand investigation, reveals that the results obtained under the new system range from good to bad. Experiences of these cities demonstrate that the mere adoption of the manager plan by the voters of Indianapolis at the special election June 21 will not prove to be a cure-all for the political ills of the Hoosier capital. But it is possible for Indianapolis to profit by the mistakes of other cities and obtain a satisfactory government, free from bossism, under the manager plan.

The manager governments reviewed in the series of articles in The Star were Cincinnati, Dayton and Cleveland, O.; Grand Rapids and Kalamazoo, Mich.; Kansas City, Mo., and Michigan City, Ind. There are 347 municipalities in the United States operating under the manager plan. Most of these are relatively small cities and towns. Only three cities are really comparable to Indianapolis. They are Cincinnati, Kansas City and Cleveland. In these cities the plan has been in operation from one to four years.

Two Steps At Once Necessary

If the experience of these cities means anything, then Indianapolis, if it adopts the manager plan, should take steps immediately to guard against the capture of the new form of government by organized minorities or by one or the other of the political parties.

Two things are necessary in order to obtain anything approximating the ideal of the manager plan. They are:

1. Establishment of a nonpartisan organization of citizens. Such an organization must be constructed as thoroughly as a political party. It must have a headquarters ably managed with workers in the precincts and wards. This organization must be provided with ample funds.

2. The city manager statute of Indiana should be radically amended at the 1929 session of the Legislature to provide a reform of election methods. The best election machinery known for obtaining the ideal of the manager plan is the proportional representation method of voting. Without this method it is doubtful whether the best results can be attained under the manager system.

Larger Cities Offer Plunder

Operation of the manager plan in cities of fewer than 200,000 population may prove satisfactory without resorting to precautions necessary in a metropolitan city. In Dayton, for example, the manager ideal of nonpartisan government is being maintained by the influence of the big industries of that city. They really control the destiny of the government. The powerful influence of the dominant industries of Grand Rapids and Kalamazoo are essential to the operation of the manager plan in those cities. The political parties in these cities must behave. They must rely on the persons associated with these industries for revenue to conduct the state and national campaigns.

In the smaller cities the incentive for selfish interests to finance a campaign to capture the government is not so

great. But in a large city the plunder that may be obtained by controlling an administration is so great that investments in campaigns may prove profitable.

Cincinnati is Best Example

Of the three large cities comparable to Indianapolis it has been shown that the manager ideal has been attained in one only—in Cincinnati. Even though Cleveland and Kansas City have election machinery far superior to the rather slipshod provisions of the Indiana law they have failed to obtain the best fruits of manager government. Due to the wisdom of the political boss of Cleveland, who realizes it is expedient to keep in pace with public opinion, that city is getting some of the benefits of the new system. But in Kansas City the plan has failed. The adoption of the manager plan there has not eliminated partisan control and the use of the spoils system of favoritism.

While there are many academic theories advanced to prove that the machinery of the manager system is better than any other type of municipal government, the real objective of promoters of the system is to free the city from the shackles of intrenched political machines.

Anything Better Than Old Plan

One of the misleading things about arguments for the manager plan is that a leader of a given city will declare that the manager system is far superior to the old government. Such statements may be truthful, but will not mean much in Indianapolis. For example, municipal reform leaders in Kansas City will declare that the manager system there is superior to the old system even though political bossism has not been eliminated.

It must be understood that Kansas City had the most obsolete form of city government in the country when it changed to the manager plan. Kansas City had the old Federal plan. The Council consisted of two houses, a lower house of sixteen elected from wards and an upper house of sixteen elected at large. Almost any system, with or without bosses, would have been better than that plan, because it made it almost impossible for the government to function at all. This was "checks and balances" run to seed.

Cincinnati and Cleveland were both cursed with the ward Council system. Cleveland had a Council as large as the Indiana Senate, elected from wards. Sectionalism and the evils of log rolling were the curse of Cleveland under that system. Cincinnati had the same thing to contend with. The ward Council system was the chief fault of the governmental structure of these three large cities.

Spoils System is Crux Here

This is not the fault being found in Indianapolis. As far as structure goes Indianapolis under the present charter has about as good a governmental plan as any city operating under the mayor-Council system. Therefore it is the partisan spoils system being attacked in Indianapolis, rather than the structure of government.

Unless a nonpartisan government is established in Indianapolis under the manager plan little, if anything, would be achieved. Probably there would be a loss.

Cincinnati has paved the way for a city that really wants to establish a nonpartisan, efficient government. In that city it was realized that the vital thing is to elect persons to the governing body —the Council—who are not prompted by selfish motives and are willing to administer the affairs of the city as a public trust.

It was believed that the manager plan of centralized government offered the best machinery under which a public-spirited group of councilmen could operate.

"P. R." Plan Must Be Used

The great difficulty was to overcome the power of the machine which had controlled the city administration for a generation. In order to do this the proportional representation ("P. R.") method of voting was provided for in the city charter. This system makes it difficult to elect slates of candidates. It therefore makes it almost impossible for organized minorities to control an administration.

Even with this safe election machinery the proponents of the manager plan as a system for municipal reform created a strong organization. This strong organization, really a loosely constructed political party, but efficiently operated, is established as a permanent institution and is called the charter committee.

Therefore the good results obtained in Cincinnati came about by reason of public sentiment, a strong organization of citizens on a nonpartisan basis, and adequate election machinery to insure proper expression of the will of voters.

Kansas City is the object lesson of what may happen where proportional

representation is not used. The citizens' committee in Kansas City was made helpless and ineffective when the two political parties started out to capture the government. They put up their slates and those slates won in the primary. When the political parties raised their war cries and went into battle no one had any time for a nonpartisan citizens' committee. Republicans lined up with their party to prevent the Democratic boss from capturing the administration. Democrats fell in line with the party. The Democratic boss won.

The experience of cities operating under the commission-manager plan demonstrates that there are two essential factors necessary to make the system function.

The first of these is an awakened public interest in civic affairs.

The second is adequate election machinery which will enable the citizens to obtain a nonpartisan, high grade commission.

All the other provisions of a city manager statute or charter are relatively trivial. If persons elected to the commission regard their positions as a public trust it matters very little whether the law under which they are operating is elaborate or brief.

In many respects the Indiana city manager statute, which the people are asked to accept or reject at the special election of June 21, is superior to the charters of other cities. It would provide for a much more simple structure than is found in most cities. This is regarded as one of the merits of the Indiana statute.

Plurality Method is Weak

But in the most essential feature it is weak. The plurality election method, provided for in the Indiana statute is an invitation to selfish interests who are expert in controlling groups and blocs of voters. The plurality election method, identical with the method now used in the election of members of the board of school commissioners, lends itself to the manipulations of slate makers.

Of course, it is possible that public sentiment may center on a group of excellent candidates and they may be elected under the plurality method. But experiences of Indiana in recent primaries, and the results in Kalamazoo, Mich., and Michigan City, Ind., both of which use the plurality method, demonstrate the danger of the system.

While the plurality election method may, at times, operate satisfactorily, it is the system that is least reliable and is looked upon as vicious by experts in municipal affairs. The best election method is proportional representation.

Possible to Amend Statute

Should Indianapolis adopt the city manager plan, it is probable that the first election of commissioners would not take place until the fall of 1929. It would be possible to amend the statute to provide for better election machinery in the 1929 session of the Legislature.

The ideal plan under which a city may operate is by the writing and adopting of its own charter. This is not possible under the constitution of Indiana. In a number of states, particularly Ohio, Michigan and Missouri, where a large number of the city manager governments are in operation, a city is permitted to draft and adopt its own charter. It is thus independent of the state Legislature in the matter of governmental structure. Indianapolis can have only such government as the state Legislature desires to provide, whether it be manager or mayor-Council.

This means that any municipal administration in Indiana must lobby at each session of the Legislature to obtain passage of necessary enabling legislation. That means, very often, the pulling of party strings. To be free from this, Indiana cities should have home rule. That can be obtained only by an amendment to the state constitution. Then enabling provisions or changes in the structure of the government could be achieved at any time by a vote of the people of the city.

Value of the Referendum

There are a number of features of city manager operation believed to be valuable by other cities. Probably the most important of these is the referendum. That is not provided for in the Indiana law as it now stands. The structure of the Indiana statute gives the city commission power to pass ordinances, but does not vest the veto power in any individual. Every other city reviewed in the series of articles in The Star except Michigan City (Ind.) resorts to the referendum as the veto power. The referendum merely means that in the event the commission passes a questionable ordinance a percentage of the electors may sign a petition and demand that the question of approving or disapproving this ordinance be decided by a vote of the people. This

power reserved to the people by the charters of other manager cities is regarded as "the gun behind the door." It need not be used often, but a threat to use it usually brings results. It is the only effectual remedy where a commission is obstinate or corrupt in matters of legislation.

One feature of the Indiana statute has proved to be an ineffective nuisance in other cities. The plan proposed for Indianapolis calls for the election of four commissioners at one time and two years later three are elected. The idea is to keep experienced men on the commission.

Little Interest in Off Years

In practice, the off-year elections, when a minority of the commission is selected, are travesties on democratic government. No interest is manifested by the electorate because there is no opportunity to change the controlling element of the government. The minority elected can not change the control of the administration even if the majority is not all that is desired. On the other hand, if a satisfactory majority is in control of the city there need be no concern about the minority elected. Dayton and Grand Rapids have this method of electing a majority at one election and a minority at another election. The elections in the years that the minority is selected are really a waste of effort and an unnecessary expense. Few persons vote and those who run are elected virtually by default.

The three large cities having the manager plan—Cincinnati, Cleveland and Kansas City—elect the entire city Council (commission) at each election. In Cincinnati and Cleveland the elections are every two years. Councilmen in Kansas City are elected every four years.

Indiana Plan Well Centralized

There are several good features about the proposed system for Indianapolis. The Indiana plan places the entire government, with the exception of two department heads, under the jurisdiction of the city manager. No other large city has gone this far in the city manager experiment, not because the proponents do not advise it, but because of reluctance on the part of the public to place all executive departments under one administrative head. If a good city manager is obtained, the Indianapolis plan is the best. If selfish interests gain control of the administration the plan proposed for Indianapolis would offer the greatest opportunity for corruption.

The Indiana plan does not provide for the recall, initiative or for civil service. None of these things is essential, according to the experiences of other cities. The recall is cumbersome and seldom used except for spite. The initiative is not vital, and mandatory civil service is not desirable. A good city manager does not need civil service machinery. A bad one will evade the provisions of a civil service law.

The essence of the theory of manager government is that it be nonpartisan. It is desired to remove from municipal affairs party alignments. In theory the system does not provide for a party of the "outs" to watch the party of the "ins." The experience of Cleveland, Cincinnati and Kansas City demonstrates that while the manager theory eliminates party alignments, they do not disappear in fact.

The proportional representation method of voting is the natural complement of the manager system. It is the one method that strikes at boss control and gives a nonpartisan organization of citizens an opportunity to elect a controlling majority of the governing body.

Students of municipal government generally are of the opinion that the manager form of city government is the best yet devised—providing proper persons are elected who will administer this system honestly. But if a partisan boss gains control of the simplified machinery of a manager government it may prove to be the most vicious form of municipal structure.

Concisely, the above is the opinion of men in Cleveland, Cincinnati and Kansas City, where municipal research organizations are maintained and headed by persons who make the study of city government a profession. In most instances these municipal research organizations are damned by the politicians in the respective cities as meddlers. But unprejudiced investigation of these organizations reveals that those in charge are unbiased students, alert to defects disclosed in practical operation of theories and candid in their statements .

It is the opinion of the heads of these organizations that the best election method for a city manager, nonpartisan government, is proportional representation. In every instance the heads of these organizations declared that the election machinery proposed for Indianapolis under the manager statute is dangerous if the people are not alert at the polls.

Proportional Representation Necessary

Operation facts in other cities prove the contentions of these municipal research organizations. Only one of the three large cities of the country which has turned to the manager plan has the proportional representation method in its best form. This city—Cincinnati—is the only one in which the nonpartisan ideal of the manager plan has been achieved.

Therefore, adoption of the manager structure of government without the added precaution of proportional representation is dangerous. Even this system may not bring the best results without an alert civic spirit among the voters.

Proportional representation is the only method that gives the people an edge over the bosses. Any other method of electing members of the city commission is subject to abuses by slate makers and bosses.

Chance to Amend in 1929

It is possible for Indianapolis to have this method of electing commissioners. It is virtually certain that there will be no election of commissioners in Indianapolis, should the people adopt the manager plan at the special election June 21, until the fall of 1929. The law of Indiana provides that the manager government can not become effective until 1930. Therefore, an amendment of the manager statute to provide for proportional representation may be effected during the 1929 Legislature.

First of all, a properly drafted proportional representation voting statute will eliminate fraud in the counting of ballots. It is no secret that the election machinery now in vogue in Indianapolis is subject to grave abuses; that the ballot is corrupted in certain sections of Indianapolis; that the counting of the ballots is done in secret after the polls are closed. There is no excuse for secret ballot counting where honest government is desired.

Slate Making Must Be Curbed

The plurality method of electing members of the commission as now provided for in the manager statute is identical with the primary method of nominating candidates for the state Legislature. Every candidate is independent. Aggressive candidates—the only ones that ever make any showing in the vote—immediately set out to make deals. They attempt to get their names on as many slates as possible. It is seldom that citizens of outstanding merit and proved ability will resort to this sort of pandering for votes. Sometimes persons of merit are drafted to lend weight to a weak slate. The evil thing about the system is that slate making is done in secret. In recent elections winning slates were folded in clothespins and dropped at the door of each voter during the dark hours of the night. The stock in trade of slate makers is religious and racial prejudices.

All of this is virtually impossible under proportional representation. Neither is a primary or any sort of eliminating event necessary under the "P. R." system. It places the minimum amount of responsibility on the individual voter, is simple to vote, effective and is more economical than the dual plan of holding a primary and then an election.

How "P. R." Works

Here is the way proportional representation works:

Any citizen may become a candidate for the office of commissioner, if he obtains a certain number of names on a petition. It is not necessary for a candiate to get a large number of names on his petition.

All names are printed on the ballots in alphabetical order. It is required that the position of the names rotate so that every candidate will have his name at the top of the list as often as any other candidate. This is done because of the large number of unthinking voters who vote for the name at the top of the ballot, no matter who it may be.

Each elector must express a first choice. That is, he must place the figure "1" in front of the name of one candidate. If he does not express a first choice the ballot is regarded as mutilated and is void. After expressing a first choice among the list of candidates, a voter may then express a second choice by writing the figure "2" in front of another name. He may likewise express a third, fourth, fifth choice and so on, for as many persons as there are candidates, regardless of the number to be elected. For instance, if there are thirty candidates for the seven places on the commission, a voter may vote for all of them, but his voting must be in numerical order, starting with a first choice and so on down to the thirtieth choice. As a matter of practical operation, however, it is a waste of time for a voter to express more than six or seven choices.

Counting is Done in Public

The ballots thus voted in the precinct are placed in a locked box by the voter. These boxes are collected by policemen as soon as the polls close and are taken to a central hall, where they are to be counted. The work of counting is done in public. In Cincinnati groups of candidates are permitted to have watchers at the precinct polls.

At the central hall where all the ballots are taken the clerks first count the total number of ballots cast. Taking Cincinnati as an example, it will be found that the total of ballots cast is about one hundred thousand. As there are nine persons to be elected in that city, the total number is divided by nine plus one. The result is 10,000. This is called the quota. Any candidate to be elected must receive the quota of first choice votes, in this instance, 10,000 first choice votes.

The first choice votes on the ballots are then counted by the clerks. Each candidate has an individual clerk. If it is found that any candidate or candidates have received the necessary number of first choice votes they are declared elected.

Experience of Cincinnati in the first election under this system showed that only two candidates received a quota of first choice votes. Should a winning candidate receive 15,000 first choice votes and he needs only 10,000, then 5,000 ballots are taken from his stack and distributed to the second choices on each particular ballot. If this process gives any other candidates a quota of votes they are declared elected. If, by this time, a required number of candidates have not been elected, the process is directed at the candidate who received the smallest number of first choice votes. He is declared defeated and all his ballots are distributed to the second choices. In event the second choice on any ballot has already been elected or defeated, the ballot is added to the stack of the third choice candidate. This process is continued until the required number of candidates have been elected.

The method of counting is complicated, but the part the voter plays in the election is simple.

Means Election of Best Men

The net result of this system is that an individual voter only casts an effective vote for one candidate. It is the theory of the plan that every voter will have an actual first choice in any given list of names. A person of merit will be known to a certain circle of voters. He will get their votes. The chances are he will be elected. Experience shows that the persons elected are above the average because of this method of selection. It is equally plain that no slate will work. If a slate is issued it must be on the basis of first, second, third and so on choices. In most instances only first and second choices are effective. Therefore, it is almost impossible for any slate, as a slate, to win a majority of those to be elected.

This does not mean that groups of candidates are not backed by organizations under the proportional representation method.

In operation in Cincinnati there are two active organizations. One is a citizens' committee and the other the Republican party. Organization backing is necessary, but the point of the system is that the organization must pick candidates who have merit or they can not win even with active support. Under the system any large group of citizens may be represented on the council by one or two members. But it would be extremely difficult for any group to get a majority. Organized labor, for instance, may get one member. If it attempted to elect two both might fail.

The Republican organization in Cincinnati in the first election under this system thought it could use its power and elect a majority of the council. But the old-time methods failed. The powerful Republican machine elected only three out of nine. The other six were the candidates of the citizens' committee. The independent six won because they are the representatives of large groups of citizens and were pledged to conduct the manager government in accordance with the spirit of the charter —namely, as a nonpartisan, businesslike institution.

THE PLACE OF THE CITY IN HIGHWAY FINANCE

By William Parr Capes, Director, New York State Bureau of Municipal Information, Albany, N. Y.

(Address before the Governmental Research Conference.)

Revenues for highway purposes are derived from direct real estate and personal property tax, motor vehicle registration fees, fuel tax and wheel tax. All States require motorists to pay a registration fee and all except four States im-

pose a gasoline tax. The wheel tax for all vehicles is not at all general.

The specific design of the motor vehicle fees and fuel tax is to reimburse the State and local governments for the cost of regulating motor vehicle traffic and to aid in the maintenance of highways used and worn by motorists. That a large portion of the regulative cost and highway expense is borne by local agencies which receive no share of motor vehicle receipts, the cities and incorporated villages, can not be disputed. Our records show that in only four States are grants made at the present time to cities and villages generally for use in financing street work. These States are Alabama, Ohio, Oklahoma and Wisconsin. In five other States aid is given to large cities whose boundaries are co-terminus with the county boundaries. In a few instances the State aids large cities in other ways than by grants or refund of a fraction of the motor vehicle tax receipts. These either share in the cost of construction of highways within city limits which connect the street system with the State highway system or contribute to the cost of specified State routes passing through or on the outskirts of large cities. As a general rule all other States require the larger cities and villages to finance from their own municipal funds the pavements which are connecting links in the State highway system. In only three States do counties make a contribution out of county tax revenues to the financing of streets of large cities, though the situation is complicated in a number of instances by the merging of county with the municipal governmental organization. These three States are Florida, Arkansas and Washington.

The cities and villages contribute much the greater share of the revenues received by States from motorists, and they are compelled to spend annually considerable of their tax funds for the convenience and safety of both urban and rural motorists. The following is a summary of the services which the automobile has forced the city and incorporated village to give or extend and thereby increase its municipal expenditures:

1. The automobile is scattering our urban population over a greater area, thus compelling the city to provide more paved streets, fire and police protection, street lighting, street cleaning, water and sewers.
2. Cities are now compelled to keep highways clear of snow to facilitate the movement of motor vehicles during winter.
3. The heavy truck has forced cities to pay more for street paving. Formerly a four-inch base under a pavement was sufficient. Now cities must construct a six, eight, ten and even twelve-inch base.
4. The vibration of heavy trucks is beginning to affect sewer and water mains. Some experts assert that cities will eventually have to lower their water and sewer systems.
5. To check or prevent an increase in claims for damages to motor vehicles, cities are now compelled to keep their pavements in much better repair than when horse drawn vehicles prevailed.
6. The motor vehicle has compelled cities to provide more substantial and costly pavement to overcome the wear and tear of automobile chains in winter; also more substantial and wider bridges to accommodate heavy trucks.
7. Police departments have had to be increased greatly to regulate traffic and parking for the convenience and safety of motorists.
8. Cities are now being compelled to provide parking space, other than on the highway; also to widen streets to accommodate increasing traffic.
9. The activities of the automobile thief have greatly increased the work of city police departments.
10. City streets must now be better lighted than heretofore for the safety and convenience of motorists.

For all of these new or increased municipal services, made necessary by the automobile, the taxpayer who owns a motor car pays no more in municipal taxes for the benefits received than does the person who does not own an automobile.

In 1925 the special joint committee on taxation and retrenchment of the New York State Legislature, assisted by the cities, made a study of what the motor vehicle is costing the cities. In its report to the Legislature this committee said:

"An analysis of municipal expenses related to motor vehicle transportation shows that the upward trend of municipal costs is particularly marked where motor traffic touches city activities. An examination of the proportion of police appropriations devoted to traffic squads disclosed an increasingly heavy burden

of expense upon the cities for which no recompense in motor fees is received. With no appropriation for traffic squads in 1903 the proportion of police expenditures devoted to this item rose from 6.33% in 1913 to 12.78% in 1918, while the 1923 proportion is over two and one-half times the 1913 figures, or 16.03%.

"An examination of the municipal debt of seven cities shows that in 1913 the average proportion of indebtedness incurred for street improvements out of the total debt was 18.68%. The proportion rose to 23.85% in 1918 and to 26.19% in 1923. The proportionate rise can hardly be explained on any grounds other than the impetus to street paving arising from the demand of motorists.

"The effect of motor vehicles, particuly trucks, is nowhere quicker reflected in municipal costs than in the expenses for street repairing. The average increase for the seven typical cities for the twenty years, 1903-1923, is indication of a greater paved area, higher paving costs as well as the intensive wear on pavements by motor traffic. Dividing the increase into two periods, 1903-1913, and 1913-1923, discloses that the major share of the increase has occurred in the period when motor vehicles attained extensive use. From 1903 to 1913, when horse-drawn vehicles formed the bulk of road traffic, the rise in repairing costs was 100%. During the following decade, however, when the motor had largely displaced the horse, the increase was very much greater.

"The demand for improved street lighting has arisen in part from the needs of motorists. While the current appropriation for street lighting in the seven cities examined arose 124.89% from 1903 to 1923, the bulk of the increase again was centered in the decade when the use of motor vehicles became wide. The rise for this period was 90.58% in contrast to an increase of 38.68% for the preceding ten years.

"In many cities the arrests caused by violations of traffic regulations, theft or motor vehicles or other cause incident to vehicles, constitute a fourth of the total number; in few cities does it fall below 10%."

Studies made by the Bureau show that in New York State nearly one-half of the city tax dollar is now used for education and highway purposes and that these two activities are responsible for most of the increase in the cost of city government and in city indebtedness. State aid for education is general, but as yet there is very little State aid for the construction and maintenance of city highways. Traffic regulations, snow removal, and the construction and maintenance of highways are no longer strictly local. How these activities are conducted in a single city or village is now of State and national concern owing to the great amount of tourists and through truck traffic. It is just as important to the owner of a truck or to a tourist that highways within city limits be constructed and that they be maintained, properly regulated and kept open in the winter as main arteries of travel outside of city limits. Yet of the millions of dollars autoists pay annually in license fees and fuel tax to most of the States, not one penny is or can be spent within city or village limits.

It may be argued that the ability of the city to pay for highway construction and repair is greater than that of the rural districts. This may or may not be true. It depends upon local conditions. We must consider in connection with this problem not only the ability but also the power of local units to provide the necessary revenue. In New York State over one-half of the cities and all of the incorporated villages either have a constitutional or statutory limitation on the amount of money they can raise in any one year for municipal purposes. The cost of services and improvements which the automobile has forced upon municipalities is increasing much more rapidly than is the taxing power of these political units. Add to this the increasing demands for other municipal improvements and services, such for example as public recreation and the elimination of grade crossings, and one does not have to tax his imagination to realize that cities either must have State aid for highway purposes or the motorist, even though he pays a State registration fee and a State gasoline tax, will receive less service and fewer benefits.

Twelve States, including New York, have encroached upon local revenue by exempting motor vehicles from taxation as personal property. It has been estimated that if New York State motorists were required to pay this tax, the revenue would amount to almost as much as they are now paying in registration fees. Because of a similar exemption in Iowa, the Bureau of Municipal Research of Des Moines states that that city is deprived of about $15,000,000 of taxable property. This presents another very

important reason why in these twelve States at least cities and villages should receive a share of the automobile revenue.

On what percentage of the total revenue received by the State should be returned to the cities and villages, I am not as yet prepared to venture an opinion. The special joint committee on taxation and retrenchment of the New York State Legislature has recommended that 25% be returned to "remedy the present discrimination against cities and villages to provide an off-set against local revenues lost from the elimination of motor vehicles from the property tax base, and to assist localities in meeting increasing expenses caused by motor traffic." In the last report of the Highway Research Board of the National Research Council the committee which investigated the urban aspects of highway finance states it is impossible to estimate with any reasonable degree of accuracy until more detailed statistics are made available what proportion of the tax on urban highway expenditures is properly to be charged to motor vehicles.

In solving this problem the needs of three groups must be considered—the rural taxpayers, the city taxpayers and the motorist. It can not be disputed that the rural districts are in need of and entitled to State aid for highway purposes, probably somewhat more than are the urban districts because of the fact that rural highways are now used almost exclusively for motor vehicle traffic while the city streets are used for pedestrian, street railway, horse-drawn as well as motor vehicle traffic. Nevertheless the city and incorporated village has a just claim for a fair share of the revenues received from motorists. To protect the interest of motorists all State aid for urban districts should be safeguarded by provisions of law that the moneys received shall be used only for highway purposes, snow removal and traffic regulation.

GARBAGE PARK, OAKLAND, CALIF.

By W. W. Harmon, City Engineer and Superintendent of Streets, Oakland, Calif.

(From *Pacific Municipalities* for May, 1927.)

Garden lovers of Oakland, California, are not content to stop at beautifying the back yard to the complete concealment of the household garbage can, but extend their landscaping to the city garbage dump, as well.

Backed by the green Contra Costa hills outlining the Campanile clock tower on the distant university campus, facing the Golden Gate across a bay ever changing in the hourly play of light and color under prevailing moods of sun, clouds or gentle fog, Garbage Park is a public utility in the process of being made lovelier.

In most cities, the garbage disposal site is ugly, offensive, and often affects an entire neighborhood. But Superintendent of Streets and Ex-Officio City Engineer W. W. Harmon, whose idea it was, could not consider his latest project completed, nor finished in workmanlike manner, without regard for a setting worthy of the two gracefully poised cranes he designed, with their patterned trestlework looming picturesquely against sky and water, and beneath them the great, red, boxsided steam barges swinging alongside the wharf.

A tribute to city engineering and landscaping, stands Garbage Park, dedicated on November 11, 1926, sponsored by its engineer-builder, with a flag-raising ceremony.

Out Beyond the Golden Gate

Oakland garbage disposal is handled by the Department of Streets. The City recently was faced with the need for a new method of taking care of its garbage, and out of several propositions there was finally adopted and put into successful operation the disposal-at-sea system, of dumping 40 miles out beyond the Golden Gate. The city hauls to the loading wharf on the western water front, and provides means for handling and filling the steamer barges owned by the removal contractors. On the wharf is installed the automatic garbage loader, machinery and operators' house, all steel framework. The plant handles 270 tons a day, the bulk being loaded between the hours of 1:30 and 4:00 P. M. Each ship requires two days to load, and dumps in a few minutes. On the way in, it receives a thorough hosing with sea water, and each evening the loading wharf and skips are similarly washed.

There is a great, square, steel skip with hinged bottom, which slides filled to the end of the crane and lowers by wire-stranded cable to drop its load inside the barge, returning to be replaced by another full skip. Is there that unmistakable odor? Yes — of honeysuckle, roses, fresh grass, and the clean, salt-

tanged breeze blowing about the bay through the Gate! Under such circumstances, visitors are tempted to stroll close to watch the smooth working of the huge unit, moving easily back and forth on a track to pick up the waiting skips quickly filled by the passing string of trucks and wagons. Beside it is a duplicate auxiliary, ready to take up work if needed. As near, indeed, to everyday home life as the house water, heating, and sewer systems, lies this labor saving device of modern engineering skill and ingenuity. It ranks as fairly in its marine and garden surroundings as do those smaller domestic engineering achievements privately installed.

From a sanitary standpoint, the system is as efficient as is possible for this kind of work. The plant is entirely free from rats and flies, and even the seagulls give it no attention. Formerly, city garbage was used to fill in the extending water front, and was compacted down and covered with sand pumped in from the bottom of the bay. This method, however, had to be discontinued on account of rat infestation.

Rye Grass and Flowering Shrubs

The present site was filled in with ocean-dredged sand, which carried 6 to 7 per cent salt, but washed itself to 1½ per cent—an amount beneficial to plant growth. Before long there was a luxuriant stand of wild grass and sunflowers. Tomato seeds blown over from an adjacent cannery took root and produced many a luscious supplement to the workmen's noontide lunches.

The gardens are laid around and inside a triangle of graded roadway, leading from the weighing house at the entrance northwesterly past a space devoted to burning old boxes, to the loading platform along the west of the one and one-half acre tract, thence back along the south side to weigh out at the entrance again. The central plot is grass planted, with a raised mound in the center, topped with ornamental grass. There is also a bed of brilliant canna, various rose bushes and shiny-leaved flowering shrubs, which flourish so well in northern California climate. Ivy will cover the slope to the water which backs the dumping platform, just touching the bank. Herbaceous plants form borders. A natural arrangement is adhered to. The edging of the road is trimly affective with a row of flat, white, broken cement paving stone. Rye grass is planted on the south side between weighing and tool house, and another shrub and lawn garden lies on the northeast inside the fence as far as the burning space. Northward still is another triangular piece being cleared and leveled for planting. Later the roadway will be graveled. Several young trees have been set out and are well along. Neat, low, wooden rail fences, tank-and-pump house, weighing and tool houses are all painted white and a chain swings between two low entrance posts.

The caretaker divides his time with other duties. Trucks coming in are so carefully loaded that only an occasional bit of paper or cabbage leaf flutters to the driveway. Plants, trees, and their placing have all been contributed by interested citizens, and no expense was involved for these. The amount of care required is minimum. Climate of the bay region is equable and moist throughout the year, with seasonal extremes of rainy weather. The same possibilities exist for localities less favored, however, except, perhaps, in the advantage of scenic attraction. Combined beauty and utility, of course, are seldom impossible where there exists vision and a regard for order.

A pretty oasis in the stretch of waste land jutting out into the bay, Garbage Park is already an objective for sunset driving.

THE INDIANAPOLIS WATER COMPANY RATE CASE

By Joseph J. Daniels, Attorney, Indianapolis, Ind.

(Paper read at 1927 meeting of the Indiana Section of the American Water Works Association.)

In October, 1924, Judge Geiger, sitting in the United States District Court for the District of Indiana, at Indianapolis, in a suit brought by the Indianapolis Water Company against the Public Service Commission of Indiana, issued a permanent injunction against the enforcement of certain rates theretofore prescribed by the Commission, on the ground that those rates were not sufficient to yield the Water Company a reasonable return upon the fair value of its property and therefore were confiscatory and in violation of the Water Company's rights under the 14th Amendment to the Federal Constitution. The case was appealed by the defendants to the Supreme Court of the United States and was argued before that court last April. On Novem-

ber 22, 1926, the Supreme Court handed down its opinion, written by Mr. Justice Butler, affirming in all respects the decree of the District Court. I have been asked to comment today on the salient features of that decision.

I think it may fairly be said that the case is, and will be for some time to come, a land-mark in the law relating to the valuation of utility properties for rate-making purposes. It certainly is so regarded by the bar generally and by the utilities. Almost every day, and certainly on an average of once a week, our office receives a request for copies of the Water Company's brief or of the printed record in the case. You may be interested to learn that counsel for the railroad companies, many of whose properties are approaching a final valuation by the Interstate Commerce Commission regard the case as having an extremely significant bearing on their present problems.

Much that is inaccurate and misleading has been written and said about the decision. Like any other court decision dealing with complicated details and difficult legal questions, the decision must be carefully studied in order to be correctly understood and explained. I shall not discuss the erroneous statements that I have seen and heard concerning the case, but I shall endeavor to give you, concisely and accurately, the questions of law which the case decides.

The opinion discusses and passes upon seven legal propositions relating to the valuation of utility properties for rate-making purposes. I shall take these up in substantially the order in which the Supreme Court decided them.

I. How is the Present Value of a Utiilty Property to be Ascertained?

At the outset, it should be kept in mind that in all cases where property, or its use, is to be taken for the benefit of the public, the main question to be settled is: What is the "present value" of the property? No one contends that any value other than the *present value* is to be ascertained and declared. If the property be real estate, and therefore has a market value, the present market value is the present value to be ascertained and declared. If it is a public utility plant made up of many parts, which plant as a whole has no *market* value, the simple rule of market value can not be applied, and in such cases, the law, by the courts, lays down rules, which the fact-finding tribunal—court or commission—must follow in determining what is the "present value" of the property that must be found and adjudged. In the Indianapolis Water Company case opinion the Supreme Court has, I believe, clarified those rules and made them more explicit than in any of its previous opinions on this subject. It has been said that the opinion holds unqualifiedly that present value is to be ascertained on one basis only, viz., the basis of the cost of reproduction new at present prices, less depreciation, if any; in other words, that so-called "spot reproduction cost" measures, and is the only measure of, present value. The opinion does not so hold. But it does lay down, more definitely than the court had done in any of the prior rate cases, certain rules and guides to the ascertainment of present value, and these rules, taken together, will, if properly applied in any given case, lead to a correct determination of what the Supreme Court think is present value. These rules may be summarized as follows:

Original cost is a fair measure of present value if *and only if*, there has been no substantial change in the level of wages and prices since the plant was originally constructed. For example, the present value of a plant constructed a year ago may fairly be measured by its actual cost, for there has been no substantial change in price levels in the past year, but, the Supreme Court says, original cost has no pertinency at all in determining present value when there has been a substantial change in the level of wages and prices since the construction of the plant. In ascertaining the value of a plant in 1927, the Supreme Court would reject as irrelevant evidence of its cost in 1907.

Spot reproduction cost, as I have said, is not the *only* measure of present value. It is the measure of present value in the absence of proof of facts requiring some departure therefrom. What are such facts? They are the facts adduced with reference to the probable level of prices and wages during a reasonable period in the immediate future. The opinion states: "In the light of all the circumstances there must be an honest and intelligent forecast as to probable price and wage levels *during a reasonable period in the immediate future.* In every confiscation case, the future, as well as the present, must be regarded." For illustration, suppose that the present spot reproduction cost of a property is $1,-

000,000; but proof is adduced that the trend of prices is unmistakably downward and will, so far as can reasonably be foreseen, continue so for at least two or three years. The Supreme Court, in such a case, would sustain, as non-confiscatory, a present-value finding of less than $1,000,000. The converse would necessarily be true, if there was clear proof of a definite upward trend in wage and price levels. But if there is no proof of a trend either way for a reasonable future period, then present construction cost is the fair measure of present value. The Court says: "If the tendency or trend or prices is not definitely upward or downward, and it does not appear probable that there will be a substantial change of prices, then the present value of lands, plus the present cost of reconstructing the plant, less depreciation, if any, is a fair measure of the value of the physical elements of the property." Thus there must be in every case more than a mere slapping of the yard-stick of spot reproduction prices to the plant under evaluation. A common-sense and good faith forecast of "probable price and wage levels" for the next few years must be applied to the present reconstruction figures. The result will be present value.

The Supreme Court had—at least many of us thought that it had—laid down substantially the foregoing rules in the Southwestern Bell Telephone Company and the Bluefields Water-Works case, decided in the spring of 1923. But following closely on these last two cases came the Georgia Railway and Power Company case, which many commissions and municipalities and others felt denied the logical implications of the Southwestern Bell and the Bluefields decisions and left the Supreme Court's position still undefined and uncertain on the question of the weight to be given to testimony of present reproduction cost and original cost figures. The Indianapolis Water Company case is the first case since three above-mentioned to present squarely to the Supreme Court the question of the ascertainment of present value. The decision is therefore especially significant and not-worthy, and I think it will be agreed by every fair-minded person who studies the opinion, whatever his personal leanings and affiliations may be, that the decision lays down the rules which I have briefly stated above, on the subject of the correct method of finding the present value for rate-making purposes of a property devoted to the public service.

May I point out, briefly, before I leave this subject, one fact that I think has been generally overlooked in contemporary discussions of the rule of present value? Although it has been useless for years, in the light of many Supreme Court decisions, to argue for original cost as a measure of present value where there has been a substantial change in price and wage levels, and although it is equally useless, in the light of the Indianapolis Water Company decision and other Supreme Court cases, for the alleged protagonists of the peoples' interests to inveigh against the importance attached to reproduction cost under the rules that I have just stated, it may nevertheless be interesting to know that the courts first rejected "original cost" as a measure of present value, and first sanctioned the use of spot prices as evidently though not necessarily controlling, at the instance and urging, not of the utilities, but of the consumers. In the 1890 decade the courts had before them cases involving the valuation for rate making purposes of railroads and other utilities constructed in the days of high prices following the Civil War. The utilities desired rates based upon those high prices and therefore argued for original cost. The consumers declared the idea of original cost to be anathema and urged upon the courts the common-sense doctrine of present value, based on the declining prices of the nineties. Their arguments prevailed, as shown by the following brief excerpts from two cases on this subject (San Diego Company against National City, and San Diego Company against Jasper), decided by the Supreme Court in 1899 and 1903 respectively. I quote from those decisions:

The contention of the appellant in the present case is that in ascertaining what are just rates, the court should take into consideration the cost of the plant, the cost per annum of operating the plant, including interest paid on money borrowed and reasonably necessary to be used in constructing the same, the annual depreciation . . . . and a fair profit to the company . . . . Undoubtedly all these matters ought to be taken into consideration and such weight be given them . . . . as under all the circumstances will be just to the company and to the public. The basis of calculation suggested by the appellant is, however,

defective in not requiring the real value of the property . . . . to be taken into consideration . . . . . The property may have cost more than it ought to have cost and its outstanding bonds for money borrowed may be in excess of the real value of the property. (San Diego Co. v. National City, 174 U. S. 179, 19 Sup. Ct. Rep. 804.)

And the following:

It is no longer open to dispute that under the Constitution "what the company is entitled to demand . . . . is a fair return upon the reasonable value of property at the time it is being used for the public. . . . . That is decided, and is decided as against the contention that you are to take "the actual cost of the plant, annual depreciation, etc., and to allow a fair profit on that footing over and above expenses." . . . . The only evidence in favor of a higher value in the present case is the original cost of the work, seemingly inflated by improper charges to that account and by injudicious expenditures. . . . . In this way the appellant makes the value over a million dollars. No doubt cost may be considered and will have more or less importance according to circumstances. In the present case it is evident . . . . that it has very little importance indeed. (San Diego Co. v. Jasper, 189 U. S. 439, 23 Sup. Ct. Rep. 571.)

And the court then proceeded to hold that the present fair value of the plant was not in excess of $350,000, against the million dollar figure urged by the Company in that case on an original cost basis.

But as you all know conditions have altered materially since the 1890's. As Shakespeare quaintly puts it "the whirligig of time brings in his revenges," and with the reversal of conditions brought about by the World War, the people's representatives have been blind to what was so evident to them in the 1890's, the fairness and virtue of the reproduction cost theory. In the heat of conflict there is necessarily a tendency to take a short perspective in these matters, but if one takes for a moment the longer view it is not difficult to visualize the public in the 1940 decade praising the Supreme Court for not having yielded to the blandishments of the "original cost" theory in the 1920's. And, after all, how many people who built, let us say, rental properties in 1910, base their rentals today on what the properties cost them? They charge rents based on the present value of the properties. In principle this is precisely what the Supreme Court has said that the utilities are entitled to do. So much for the Supreme Court's ruling on the rules for ascertaining present value in the Indianapolis Water Company case.

II. What is a Reasonable Rate of Return on the Fair Present Value of Utility Property?

Here, again, there has been some misconception of the Indianapolis Water case opinion. The Supreme Court did not fix 7 per cent as the maximum. It said that the evidence was "more than sufficient to sustain" a 7 per cent return and that "recent decisions support a higher rate of return" and it cited, among the ten decisions supporting a higher rate of return, several cases allowing 8 per cent. But the Court did not find it necessary, upon the record before it and the state of the issues, to go further than to decide that a reasonable rate of return was "not less than 7 per cent." The Court did, however, state clearly that in any utility case the rate of return can not fairly be measured by the cost of bond money to the company. The Court said:

It is obvious that rates of yield on investments in bonds, plus brokerage, is substantially less than the rate of return required to constitute just compensation for the use of properties in the public service. Bonds rarely constitute the source of all the money required to finance public utilities. And investors insist on higher yields on stock than current rates of interest on bonds. Obviously, the cost of money to finance the whole enterprise is not measured by interest rates plus brokerage on bonds floated for only a part of the investment.

Thus the case may fairly be cited to sustain the proposition that the rate of return depends upon "the cost of money to finance the whole enterprise."

III. Must There be in These Rate Cases an Allowance for Working Capital and Materials and Supplies?

The Supreme Court in the Indianapolis Water Company case answers this question in the affirmative, in a short paragraph. It was contended by the appellants that the company was entitled to no working capital allowance because it could get its necessary working capital from pre-payments by consumers. The Court's decision, approving the allowance for working capital, rejects this contention.

IV. Is a Utility in a Rate Case Entitled to an Allowance for Water Rights, Upon Proper Proof of Their Existence?

The Supreme Court holds unequivocally that it is, thus reaffirming the position that it took on this question many years ago and from which it has never departed.

V. Going Value.

The opinion of the Supreme Court, definitely, I think, disposes of the contention, which has been urged at various times and in various cases in the last few years, that no allowance for going value is permissible in a rate case. This argument was based—unsoundly, it is now clear,—on the Galveston and Houston cases in the Supreme Court. Those cases did reject allowances for going value, but they rejected them because the companies had attempted to base the calculation of their going value on past losses. In the Indianapolis Water Company case the Supreme Court cited several of its own earlier decisions as sustaining an allowance for going value and laid down the rule upon this subject in the language of the Des Moines gas case as follows:

That there is an element of value in an assembled and established plant doing business and earning money, over one not thus advanced, is self-evident. This element of value is a property right and should be considered in determining the value of the property, upon which the owner has a right to make a fair return. The court in its opinion does not attempt to lay down any rule-of-thumb for calculating the proper amount of going value in all cases but it does make some comments as to the amount properly allowed for this item to the Indianapolis Water Company which are perhaps significant as indicating generally the Court's views on this subject. After pointing out that the Commission had allowed for both water rights and going value an amount less than 6 per cent of the value of the physical properties found by the Commission, the Supreme Court says emphatically:

Having regard to the character of the system, that amount is clearly too low. . . . . The evidence is more than sufficient to sustain 9.5 per cent for going value. And the reported cases showing amounts generally included by commissions and courts to cover intangible elements of value indicate that 10 per cent of the value of the physical elements would be low when the impressive facts reported by the commission are taken into account.

It would therefore seem reasonably safe to believe from the opinion in the Indianapolis Water Company case that in any case where the evidence shows the existence of an assembled, established, well-managed, efficient and productive plant, the Supreme Court will approve an allowance for going value of at least 10 per cent of the value of the physical properties.

VI. Calculation of Depreciation.

The opinion deals a death-blow to the theory of "straight-line" depreciation, which had been urged and argued for in the appellants' brief, and proves beyond question that the Supreme Court will reject large deductions based on assumed depreciations calculated on theoretical and arbitrary bases, in every case where the record contains trustworthy testimony by competent engineers who have made an actual inspection of the properties and estimates, based on their inspection, of the percentage of depreciation. The "straight-line" theory, as you know, is based on the age and the assumed life of a particular article. Thus: It is assumed that a piece of pipe will last fifty years. A particular piece of pipe is twenty years old. Therefore there must be deducted, in evaluating it, 40 per cent of its present value, regardless of its actual condition, and evidence of its actual condition is immaterial. It will certainly be useless, since the Water Company decision, to urge this "straight-line" theory. In the trial court the Water Company had presented two theories for providing for the depreciated condition of the property. One was the testimony of a competent engineer who inspected the property and based his estimate of the percentage of existing depreciation on his inspection and a consideration of the probable future life of the property as indicated by the conditions he found. The other was the testimony of a competent engineer who inspected the property and calculated the amount of money that would be required to restore the property to its condition when first installed. The Supreme Court's opinion does not indicate a preference for either of these two theories. Apparently it approves both; certainly it rejects *in toto* the "straight-line" method.

VII. What Property is to be Valued?

Or, phrasing it differently, how far

may a commission or court go, in calculating present value, in substituting for the value of the actual plant the value of a different plant which the tribunal assumes would be more efficient or more economical in operation than the actual plant? This question was presented to the Supreme Court in the Water Company case by the testimony of one of defendants' witnesses who contended that a steam plan should be substituted for the lower part of the canal at a saving alleged by the witness to be nearly $1,000,000 in value. The Supreme Court completely rejects this attempted substitution and lays down the rule that what is to be ascertained is "the value of the plant used to give the service and not the estimated cost of a different plant." This is not to say that in every case the court will permit the inclusion, in the valuation of the property actually being used, no matter how obsolete and uselessly expensive it may be. But the Supreme Court says that "save in exceptional circumstances" it will not enter upon a comparison of the methods of different systems. It is clear, therefore, that in the ordinary case, where a utility is in good faith using a particular plant or a particular kind of machinery, the court will not permit the value of that plant or machinery to be excluded from the valuation by testimony attempting to show that some assumed substituted plant or piece of machinery would do the same work more cheaply.

I hope that I have succeeded, in what I have said, in showing the importance that the Indianapolis Water Company decision by the Supreme Court of the United States is bound to assume in future rate controversies. Practically every rate case involves the question of the method of ascertainment of present value, and the question of the proper allowance for going value. Many rate cases involve the questions of reasonable rate of return, allowance for working capital, allowance for water rights, method of calculation of depreciation and questions involving substitutions. Upon all of these questions the Water Company decision is a clear-cut precedent and it will be followed by every court and commission to which it is cited except those, if any there be, which no longer regard the decisions of the Supreme Court of the United States as the final authority.

DISPOSAL OF TRADE SEWAGE

By C. H. Currie, President, Currie Engineering Co., Webster City, Iowa.

(Read at 1926 Conference on Sewage Disposal at Ames, Iowa.)

Trade wastes are distinguished from the usual domestic wastes of a community, and may require separate methods of treatment. This may consist of complete separate treatment, or of sufficient preliminary treatment to produce wastes, which may be turned in with the community sewage and finally purified in the community sewage-treatment plant.

The importance of the proper disposal of trade sewage is becoming more apparent every year. Many of our smaller communities are finding that their sewage-treatment plants, which in the past may have given good satisfaction, are unable to treat properly the sewage they receive. The increase in dairying and the consequent increase in dairy wastes produced in small towns, together with the sewage from canning plants, sugar-beet plants, and many other industries, often put a load of concentrated wastes upon the municipal treatment plant that it can not be expected to handle.

This does not mean that all towns having small creameries, or even that all towns having small canneries, may be having trouble with trade sewage at the present time. The carelessness of employees, in many creameries, permits too much of the washings with a feeding value to waste into the sewer. This may increase the concentration of the creamery waste to a point where proper functining of the sewage-treatment plant is seriously disrupted, and a nuisance is created. The most serious problems in trade-waste sewages are the nature and concentration of these wastes. Many trade sewages, such as creamery and cannery wastes produce acid fermentation, and either totally or partially interrupt the proper digestion of solids in the settling tanks, thus causing total or partial disruption of the entire sewage-treatment plant. Until very recent years little has been known of the nature of the trouble caused. The advance in the science of sewage-treatment, however, and especially the active studies being made by bacteriologists and chemists, are showing us that trade sewages usually present individual problems that need to be worked out by themselves.

Methods of Disposal

There are three general ways in which trade sewages may legitimately be han-

dled: (1) by fine screening with sufficient dilution to prevent undue stream pollution or to constitute a public nuisance; (2) by a partial treatment of the trade sewage in order to destroy the acid-forming bacteria or to change this sewage to the equivalent of ordinary domestic sewage, so that it can be run into the municipal sewer system and put through the treatment plant in the regular course; (3) by the complete treatment of the trade sewage, so that the resultant liquid can be wasted in any stream or storm sewer. The nature of this treatment would, of course, depend upon the nature of the trade sewage itself and might present a considerable problem.

Disposal Problems Compared

Many industries, such as canning plants and sugar-beet plants, operate but a very short period in the year, but their daily volume of sewage may be large. The cost of a sewage-treatment plant of the sort usually designed for municipalities, would probably be so high that it might mean the moving or abandonment of the industry in favor of another locality. It is quite possible, however, that much cheaper treatment plants may be constructed by utilizing available materials. The elimination of labor in the design of a municipal plant is important; while in a plant handling trade wastes (but only operating for a short season), this item is not so important. The question of pumping is somewhat similar. While this operation should be avoided in municipal plants where possible, pumping might well be warranted in the handling of short-season trade sewage, when by so doing the capital investment can be reduced.

Disposal of Beet-Sugar Wastes

The case of a sugar beet company may be taken as an illustration. This summer an experimental plant has been worked out in an attempt to determine: (1) Whether a direct trickling over beds of stone would produce a stable effluent that could properly be discharged into the creek, and to determine the cheapest materials that could be used as a filtering medium, if such a method of purification proved satisfactory. To that end a temporary trickling filter with five compartments has been constructed—one with cinders from the company's power plant; a second, using screened cinders from the same source; a third, using sized or double-screened cinders; a fourth, using broken tile, which can be secured very cheaply; and a fifth, using screened gravel.

The probale amount of liquid that will have to be treated at this sugar-beet plant, will eventually run in the neighborhood of six million gallons per day. If crushed granite of the sort usually employed in Iowa were used, on the basis of two million gallons of liquid per acre per day (which may be high), the cost of the filter stone alone would be approximately $90,000. Should gravel prove a satisfactory medium, the cost for the material alone would be approximateyq $60,000. Should the broken tile prove satisfactory, the cost of the material in place would be approximately $35,000. Should screened cinders be used, the cost would be about $28,000. Should the cinders, as they come from the cinder pile, prove satisfactory, the total cost in place would be approximately $20,000.

You can see from this specific case that it is well worth the while of any industry to make a careful study of its problems, as there is a possibility at least of a tremendous saving in capital investment.

Effect of Trade Wastes on Sewage

As an illustration of the effect of a trade waste upon a sewage, a certain sewage-treatment plant designed and built some years ago, operated very satisfactorily until a canning plant dumped its sewage into the city sewers. Thereupon the Imhoff tanks immediately went out of commission, foaming violently, causing disagreeable odors, carrying over solids to clog the trickling filters, and in general disrupting the sewage-treatment plant for the period of the canning season, and some weeks afterwards.

A careful analysis of the liquid from this canning plant has since been made from samples taken at the plant, from the creek above the plant, and from the creek about a half-mile below the plant. While the samples from the creek above the plant showed some pollution, it was insignificant compared with the pollution below the plant. The waste liquid itself showed a great tendency toward acid fermentation as the first stage, which was undoubtedly the primary cause of trouble at the municipal treatment plant.

The analysis of the waste from this particular cannery indicates that it acts very similarly to the waste from a typical creamery. Possibly the same general method of treating creamery wastes might well be tried out in this canning-plant waste.

It would probably be necessary, how-

ever, to add fine screening in order to remove the coarse corn waste, pea hulls, tomato seeds and skins, and similar material ordinarily found in canning-plant wastes.

There is no general rule by which a community may solve its particular problem, but each community owes much to its industries, and should cooperate with them in securing expert advice to solve their mutual problems in the most economical and efficient manner.

STANDARDS OF ADEQUATE FIRE PROTECTION

By George W. Booth, Chief Engineer, National Board of Fire Underwriters.

(From the National Municipal Review for April, 1927.)

For more than a score of years the engineers of the National Board of Fire Underwriters have been surveying and assaying the fire defenses of the larger municipalities of the country and as a result of their experience have devised what is known as the "Standard Grading Schedule." This is in the nature of a detailed fire hazard diagnosis. The factors given particular attention include water supply and distribution, structural conditions, building codes, fire department equipment and operation, administration of hazardous occupancies, etc. The total scoring embraces 5,000 points, of which the fire department's share is 1,500. The qualifications of the chief departmental executive, company officers, method of appointment, enlistment and promotion, retirement provisions and many similar items are given attention.

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The number of engines or hose companies required by the schedule is predicated upon a formula devised in the light of experience and is based on total population and the motive force of the apparatus. The ordinary formula for motor equipment is 0.85 plus 0.12 P, the letter P representing the population in thousands.

Cities of over 20,000 require ladder companies equal to 1 plus 0.03 P, and an aerial ladder is called for in districts where there are five or more buildings four stories or higher. Reserve trucks should be provided in the proportion of one to five of those regularly in use.

In regard to the distribution of fire companies, it is held that in a mercantile or manufacturing district there should be at least one engine or hose company of the horse-drawn variety within a distance of one-half mile of every point, and a ladder company within a three-quarter mile distance. If the apparatus is of the automobile type, one-quarter of a mile is added in each case. In residential sections, the distance may range from a mile to a mile and a half for engines and hose wagons and from one and one-half to two miles for ladder trucks.

The ideal company membership in high-value districts where the apparatus is horse-drawn, calls for the following minimums:

High Value District	*Day*	*Night*
Engine	7	9
Hose	5	7
Ladder	7	9
Water tower	1	1

Slightly smaller numbers are permitted in engine companies where only motor driven apparatus is employed.

Ladder companies equipped with quick-raising devices on the aerial ladder require one man less on each shift.

The addition of two men for each company on the night shift is due to the increased difficulty of operation at night.

As far as engine capacity is concerned, it should be two-thirds of the required fire-flow, as determined by the water supply grading, with credit given for available fire-flow at 50, 60 or 75 lbs. residual pressure, depending upon the number of high buildings. Reserve engines should be provided so that if one-eighth of the number of regular pieces of apparatus are out of service, there will be no deficiency.

The equipment should include powerful stream appliances, such as turret-nozzles, deluge sets, siamese couplings, cellar pipes and ladder pipes. Water-towers are required in districts having more than ten six-story buildings.

All hose and ladder companies should be equipped with small extinguishers and it is best for hose wagons to carry chemical tanks of at least 35 gals. capacity, since the quick use of the small streams from these tanks is of material assistance in keeping down water damage.

Hose requirements call for at least 1,000 ft. of 2½-in., or larger hose, per company with an equal amount of reserve, and a loaded reserve wagon should be kept on hand for emergency use. Owing to the decreased loss by

friction it is suggested that hose companies responding to alarms in congested districts carry 500 ft. of 3-in. hose, and engine companies and other hose companies, 200 ft. each. All hose should be tested regularly, since mere visual inspection will not reveal all defects.

II

An important requirement in the interest of fire department efficiency calls for the regular drilling of the men by an experienced officer, the exercises embracing training in modern methods of fire fighting and also physical culture. Discipline should be strict.

While it is not recognized that there are defects in the civil service method of appointment where selections are based entirely upon the outcome of examination, it is nevertheless believed that the appointment and promotion of all fire department employes under this system is productive of the most satisfactory operations. Political appointments have a number of unfavorable aspects including the likelihood of changes every few years. The best results are obtained where the fire chief and his higher officers are not subject to political pressure, or dismissal for party reasons. It should be appreciated, however, that retirement should take place after both officers and men have reached the point where their efficiency is no longer at par. It is believed that the retiring age should be the same as that which rules in the army and navy. A fire chief is, during a conflagration, under a strain comparable to that experienced by an army officer in battle, and he knows that if he is disabled at such a time, or makes an unwise move, the consequences may be disastrous both to life and property.

Building inspections should be made periodically by firemen and company officers, who should be empowered by law to enforce corrective measures.

Other factors taken into consideration in connection with fire department operation are response to alarms, actual performance at fires, and physical conditions that have to be overcome, such as obstructions due to overhead wires, railroad crossings, poor city pavements, and so on.

It is maintained that a good water supply system in a city where the fire department is poor, or vice versa, does not result in protection as effective as that which would prevail if both were only fairly good.

III

The fire alarm system is of great importance. Boxes should not be more than 500 feet distant from any building in mercantile and manufacturing sections and not over 800 ft. distant in closely built residential areas. They should be of the so-called non-interference, succession type which in the case of simultaneous alarms permits each box to transmit its signal without confusion. Keyless boxes are favored since there is always a loss of time in obtaining the key from some neighborhood cache. The National Board recommends that there should be not more than twenty boxes on one circuit and that the fire alarm headquarters should be in a fire-resistive building, situated in an isolated spot such as a park or large square. The fire alarm system is marked for 550 points of efficiency, the police department for 50 and the buildiing laws for 200.

Climatic conditions must likewise be taken into account since prolonged dry spells, or severe cold weather with heavy snow falls and high winds, increase the likelihood of fire and affect operations as well as the response to fire alarms.

INDIANA UTILITIES PAY 17 PER CENT STATE TAXES

Seventeen per cent of the taxes collected in Indiana are paid by public utility companies, according to Hon. Fred A. Sims, of Indianapolis. Mr. Sims, formerly chairman of the State Tax Board, spoke recently at the School of Commerce, Indiana University, on "Methods of Taxing Public Utilities." He said:

"Public Utility corporations represent a very important part of the property valued for taxation in this state. In 1925 the total of these valuations was $894,234,797.00, or practically seventeen per cent of the entire tax duplicate of the State of Indiana. Of this amount steam railroads were by far the largest, totalling more than $525,000,000. The next item was that of public utility companies, consisting of heat, light and power, totalling more than $129,000,000. The importance of these properties as revenue producers may be additionally illustrated by the fact that in 1915 they represented 12.88%, while in 1925, it was 16.97%, of the total property value for taxation in the State of Indiana.

"These valuations are spread over the

entire state. In many counties they form a most important part of the public revenue. In two, or perhaps three counties, these valuations constitute more than one-half of the entire taxable property of the country. Without them the problem of local taxation would be, in a large majority of our counties, seriously affected."

Actual value, rather than capitalization or security issues, must be the basis of taxation, Mr. Sims declared, saying:

"In determining this valuation for taxation, the question of capital value, that is to say the value of capital stock and capital investment, together with earning power, is given consideration, but as a rule intangible values are excluded in the amount fixed, the object being to assess the property of a tangible character, at a going value. In considering capital investment and earnings, the object is rather to find tangible value as a going concern, rather than to include intangible items in the taxable value of the property. Some special attention may be directed to this point, as it may throw some light upon the difference between the valuation thus found and that fixed by the Public Service Commission for the making of rates. Much has been said, and oftentimes in a public way, concerning this point.

"It has been rather difficult to understand why one value is fixed by the Public Service Commission and another upon the same property by the State Board of Tax Commissioners. The reason is found in this, that under the law the Public Service Commission finds the fair value of the business, based very largely upon the total amount of money expended or the cost of replacement, taking into account present conditions by way of depreciation. This includes, obviously, a large amount of capital expenditures, which is not reflected in the actual tangible or corporeal property.

A case in point, as illustrative of this, is the establishment of a large utility, which is in mind, where a very considerable portion of the capital expense was made in investigation, surveys, intangible water rights, architectural designs and estimates, and temporary construction, all of which were necessary and essential to the accomplishment of the purpose, but practically none of which were included in the cost value of the completed property. These, and some other items, are what might be known as the intangibles.

"None of this is included in the State Board valuation, for the reason that the object of the State Board is to value the actual tangible property, as it exists on the first day of March, of each year, and not to include items which are neither there nor which are elements of the property, properly coming under the taxing statutes as determined by the State Board of Tax Commissioners."

LABORATORY CONTROL OF SEWAGE PLANT

By Edwin S. Hopkins, Principal Sanitary Chemist, Montebello Filters, Bureau of Water Supply, Baltimore, Md.

(Paper read at conference of Maryland Water and Sewage Plant Operators.)

Laboratory control of a modern water filtration plant is essential, for the water supplied to the average city or town is a manufactured product and its manufacture must be as carefully controlled as that of steel or cement. Such a control involves both chemical and bacteriological supervision of the water under treatment. In a small plant this control is vested in one individual properly trained; in the larger ones, in a laboratory staff of chemists and bacteriologists. The standard methods of laboratory procedure for this work will be found in a text book published by the American Public Health Association entitled "Standard Methods for the Examination of Water and Sewage."

Since the fundamental task of any water plant is to deliver a pure effluent to the consumers its efficiency is controlled by bacteriological analysis. These analyses consist in placing certain amounts of the water in culture media and identifying the organisms that may be present. Samples should be tested at definite intervals during the day, every six hours or so. To test for the number of bacteria present, one c. c. of the sample is added to nutrient agar media, incubated and the number of bacteria counted. Seeking to learn the presence or absence of B. Coli, the organism used as the index of pollution, other portions of the sample are inoculated into lactose-peptone-sugar broth, incubated and if the organisms are present the sugar will be fermented and gas be produced in proportion to the density of bacteria. This is known as the presumptive test. To prove the presence of this bacillus a small amount of the sugar broth liquid, showing gas,

is placed on a special solid media (Eosin-Methylene Blue Agar or Endo Agar) and if the organism is present, growth upon this medium will be in a characteristic manner. This growth is then re-inoculated into a new tube of lactose sugar broth and if gas is again formed the presence of B. Coli is considered proved.

Similarly to the bacteriological control chemical examination is made daily. The assurance to the consumer that the water is perfectly clear, odorless, tasteless and is potable rests upon chemical control. Since alum is generally used as a coagulant it is necessary that the water be slightly alkaline at all times to completely precipitate the floc. Frequent determinations of alkalinity are made. Also it is highly desirable that sufficient alkalinity be maintained in the plant effluent to protect the pipe lines from corrosion. The soap hardness test keeps the laboratory informed as to possible complaints of hard water from domestic consumers and of boiler scale formation from industrial users. Frequent color and turbidity determinations give assurance of a clear effluent. A standard of 0.2 parts per million turbidity is maintained as the unit of plant efficiency. This turbidity is determined by three types of electric lighting devices. It is waterworks practice to determine the residual chlorine by one of two methods. Either by using the starch iodide method or the orthotolidine test. Control of chlorine dosage is necessary to prevent taste or odor or both in the supply. Determinations of hydrogen ion concentration (p H), iron, manganese and dissolved oxygen together with a monthly mineral analysis of daily composite samples reveals the constituents of the supply and indicates its potability.

Micro-organisms, algae and other growths are present in the river water and during certain seasons of the year give considerable trouble by clogging filter beds and by producing taste and odor. Frequent microscopical examinations of samples from the river enable the laboratory to check these growths by addition of a germicide if necessary.

The chemicals used in the purification process are applied by the "wet process." Analysis of the strength of these solutions as they are being applied to the water is another function of the laboratory thereby reducing waste to a minimum.

Utilizing a mechanical stirring device and a small sand filter the laboratory accurately controls the amount of coagulant used at all times. This procedure makes possible operation of the plant within 10 per cent of theoretical efficiency.

Finally, co-ordination of laboratory data is important since information is of no value unless used. Systematic control necessitates carefully recording of data and comparative study of the characteristic of the water as revealed by it, gives valuable assistance to efficient operation. There is no reason for obtaining laboratory results and then not using them.

THE ENGINEERS VOW OF SERVICE

(Editor's Note: The following "Vow of Service" has been promulgated by the American Association of Engineers. We submit it without undue and, perhaps, unseemly comment.)

We dedicate ourselves to the service of mankind as members of the Engineering Profession.

We consecrate our professional knowledge, skill, and training to the advancement of human welfare, safety and progress.

As we benefit by the technical knowledge and public esteem won for the profession by the Engineers who labored in the past, we shall ever strive to augment that heritage before passing it on to the Engineers who are to follow.

We therefore affirm our guiding purpose:

So to live and work as to strengthen the Public's esteem for the Engineering Profession, and to justify the trust and confidence reposed in us as members of that Profession.

To carry out professional engagements with generous measure of performance, and with fidelity and loyalty toward those who engage our services.

To foster a spirit of courteous consideration and fraternal cooperation within the Profession.

To extend encouragement and a helping hand to younger Engineers and to those in need.

And always to place Service before profit, the honor and standing of the Profession before personal advantage, and the Public Welfare above all other considerations.

EXPERIENCE WITH MANAGER GOVERNMENT IN VARIOUS CITIES

On June 21, 1927, the voters of Indianapolis adopted the Commission-Manager Form of Government by a vote of more than 5 to 1. During the campaign the Citizens Committee of One Thousand made inquiry as to how manager government is working out in various cities. The following telegrams are from reputable, disinterested persons living in cities under manager rule:

Kenosha, Wisconsin

From Kenosha Retailers' Association:

Business Men and Honest Politicians Heartily Favor City Manager Plan. Per Capita Cost of Operation Reduced 21 Per Cent. All Departments more Efficiently Operated on Even Less Than Budget Allowed. Value Received for All Taxes. Department Heads Have to Produce or Get Out.

Cincinnati, Ohio

From William Light, President Rotary Club:

Cincinnati Under City Manager Is Throwing Out Her Chest and Telling the World She Is Going Ahead. Economies in Major Improvements Astounding. Civic Spirit at High Pitch. Public Service Rejuvenated. City Manager Admitted to Rotary Membership Yesterday and Received an Ovation From Three Hundred Present That Stopped the Show for Five Minutes. Good Luck to You.

Knoxville, Tenn.

From Knoxville Chamber of Commerce:

City Manager Government Wonderfully Successful in Knoxville. Politics Replaced By Business Efficiency. More Street Work Done at Lower Expenditure. New Civic Center and Park Established In Uptown District. Real Health Department Established. Modern Accounting System Shows Daily Condition of Every Department. Ten Per Cent of Last Year's Taxes Refunded to Tax Payers. Police Department Under Civil Service; Great Improvement Made In Efficiency With Practically No Change In Personnel. Budget and Sinking Fund Previously Existed In Theory Only But Are Now Realities. No City in America Has Better Government Than Knoxville.

Beaumont, Texas

From Jack H. Hott, Secretary Beaumont Chamber of Commerce:

After Six Years Trial Beaumont Would Not Consider Changing From City Manager Form of Government. City Politics Practically Eliminated. This Form of Government Undoubtedly Results in Splendidly Increased Efficiency and Economy. Beaumont Progressing Rapidly and Substantially Under It.

Miami Beach, Fla.

From Clayton S. Cooper, President Rotary Club:

City Manager Government In Miami Works Satisfactorily. Our Commissioners Reputable Bankers Having Confidence of the Community. Paid City Manager Working In Close Cooperation With All Civic Clubs and Chambers of Commerce. City Manager a Rotarian. Very Little Politics Possible Except at Election Time; Great Improvement Over City Council and Mayor Plan.

Grand Rapids, Mich.

From Grand Rapids Association of Commerce:

Commission Manager Form of Government In Operation Here Since 1917 Has Proven a Wonderful Success; Centralizes Authority and Responsibility and Makes Efficiency More Possible; Attracts to City Government Men of Highest Caliber.

Dayton, Ohio

From Horace M. Huffman, President Rotary Club:

Manager Government Has Given Dayton 13 Years Continuous Business Administration. Politics Divorced From Administration and Every Official, City Manager Down, Promoted From Ranks On Merit. Low Price and Honest Performance Not Wire Pulling Get Contracts. Business Men Stronger For City Manager Plan Today Than In January 1914.

Portland, Maine

From C. H. Robinson, President Exchange Club:

City Manager Government Very Successful. There Have Been Two Reductions In Tax Rate and We Get Much More For Our Money.

Norfolk, Virginia

From W. W. Houston, Chairman Civic Committee, Norfolk Rotary Club:

Norfolk's Big Development Began Eight or Ten Years Ago With Formation of Present Non-Partisan City Manager Form of Government. Have City Manager and Council of Five Who Act as Board of Directors. Have No Graft; Economical Administration; Good Law Enforcement and Excellent Civic Spirit; Could Not Be Induced to Return to Old Political Spoils System.

Cleveland, Ohio

From Fred Sowers, Secretary Rotary Club, Cleveland:

City Manager Government In Operation Cleveland Three Years. Finances In Good Shape. Lowest Tax Rate of Any of the First Ten Cities; Ordinary Council 25 Members. Competent City Manager Probably Most Efficient Administration In Past 20 Years. People Who Want Good Government Generally Well Pleased With City Manager Plan. Both Party Organizations Supporting City Manager Hopkins. No Evidence of Graft. Housekeeping the Best Since Tom Johnson's Time. City Generally In Good Shape.

Alameda, Calif.

From George H. Hagy, President Exchange Club:

Our City Has Been Operated Under the City Manager System For Ten Years, and as I Have Been a Resident Here For the Past 36 Years, I Can Say That the City Manager Government Has Improved Conditions to a Great Extent.

Wichita, Kans.

From W. C. Coleman, President Rotary Club:

Wichita's Ten Years Experience With City Manager Form of Government Has Satisfied Everybody Except Professional Politicians and Job Seekers. It Has Made Possible the Cleanest and Best Government This City Ever Had. City Taxes Have Been Reduced While Other Taxes Have More Than Doubled. At the Same Time We Have Made More Civic Progress Than In Any Like Period of Our History. With City Manager Type of Government Our Outstanding Citizens of Unquestioned Integrity and Experience In Large Affairs Find It Possible to Accept Responsible Position With High Sense of Duty and the Ideal of Service.

Portland, Maine

From Portland Chamber of Commerce:

Council Manager Plan Five Councillors and Manager Giving Our City a Business Administration. Lower Taxes, Better Police and Fire Service, Common Sense Budget. Politicians Disgusted, Business Men Well Pleased. Everybody Happy.

Niagara Falls, N. Y.

From R. D. Glennie, The Falls Equipment Co.:

The City Manager Form of Government Was Started Here Eight or Ten Years Ago and I Am Quite Sure It Is a Great Deal Better Than the Old Crooked Grafting Government We Used to Have.

Dubuque, Ia.

From Dubuque Chamber of Commerce:

City Manager Plan Great Success In Dubuque. Old Indebtedness Being Rapidly Reduced and Taxes Somewhat Lower. Taxpayers Have Confidence In Plan and Realize That They Are Getting All They Pay For. Tax Money Is Spent Judiciously and Without Waste, Extravagance or Graft. Delinquent Taxes of Long Standing Have Been Collected. Fire Insurance Rates Reduced from Class Six to Class Three City. Police Department Operating Efficiently. Police Court Fines Have Increased From One to Seventeen Thousand Dollars Since Manager Plan Took Effect.

INDIANAPOLIS REVOLTS

(Editorial in Louisville Courier-Journal.)

The adoption of the city manager form of government in Indianapolis by a vote of 5 to 1 represents more than a popular preference for that system of organization, more than the proportion of ultra-progressives and conservatives among the Indianapolis electorate. It represents a revolt against machine politics and the acceptance of the nonpartisan way out of scandals and corruption. When machine politicians in a city like Indianapolis can muster only 9,000 votes against 50,000 in 237 precincts, and the poll is heavy in the respectable residential wards and light in the slums, it is evident that something must have happened to the machine before the polls opened.

Something had happened. The mayor and some other municipal officers had been indicted. Indianapolis, which has suffered under clown or Klan rule for a long while, was included in the exposures which Thomas H. Adams, the Vincennes publisher, proposed to make last fall if former Dragon Stephenson could be induced to talk. The people of Indianapolis have been nauseated by rotten state and municipal politics. From the smoke inspection department to the school board unpleasant things were uncovered. Then the politicians got the legislature to postpone until 1930 any change in the form of government voted by the people. That was a blunder; it seems to have made a clear cut issue in the popular mind between machine pol-

itics and the managerial form of government.

The result, regardless of the relative merits of the different forms of municipal government, is a victory for good citizenship and decent politics. Louisville congratulates her neighbor. Louisville will shortly come into a simplified system of government; but will watch the experiment in Indianapolis and Cincinnati with expectant interest, wishing for both of them success in the achievement of efficient and economic administration and freedom from the spoils on which machine leaders thrive.

The Indianapolis plan is to elect a commission, which appoints an executive to take charge of the departments of public works, safety and finances and the other administrative branches, just as a school board appoints an executive head. It is a shift from the professional politician who stands behind the administration and manipulates its acts to the professional executive expert who stands in front of the administration, which is responsible to the people for his conduct. But the success of the experiment will depend at last upon the "eternal vigilance" of the people of Indianapolis in seeing to it that the right kind of men are elected to the commission. They haven't shifted any of the duties of citizenship from their own shoulders.

THE USE OF CALCIUM CHLORIDE FOR HIGHWAYS

By H. F. Clemmer, Solvay Sales Corp., New York, N. Y.

(Paper read at Southwestern States Road School and Show, Wichita, Kans., Feb. 23, 1927.)

Everybody uses the roads, and there is no important national activity that affects more the prosperity of a state or nation.

There is no product but that is affected in some way by transportation facilities. Before the advent of the motor vehicle transportation was carried on in general by the railroads. Today the highways are playing an important part in the transportation of the country and it has become imperative that highway engineers use every effort to improve and maintain the highways to facilitate in every way the movement of passenger and freight transportation.

An improved highway without adequate maintenance is of little value. While there are many important problems for study relating to design and construction, one of the biggest highway problems today is that of maintenance of the present roads so as to afford safe and satisfactory movement for our rapidly increasing traffic. This highway service should be obtained as economically as possible. The difference in the cost to the public of traveling over the various road surfaces; the interest on the investment required to build the road; and the cost of maintenance should all be taken into consideration in the project. The road costing the least to build is not always the most economical when maintenance cost is figured, but it is not reasonable to build a high type pavement to carry a few hundred vehicles per day when a much cheaper road such as a gravel surface will carry the traffic with safety and comfort and at a much lower cost per vehicle mile.

The advent of motor traffic, in place of the slow horse drawn traffic, has created two problems in connection with the maintenance of gravel roads. First, the loss of material due to the ravelling of the road, and, second, the dust nuisance which creates a very dangerous as well as unsanitary condition. Every motorist realizes the difficulty in driving over a dusty road and the resultant slowing up of traffic. Vision is impaired and the careful driver proceeds slowly and therefore reduces the carrying capacity of the road while the reckless driver forces ahead, endangering himself as well as all other motorists on the highway.

The loss of material on a gravel road is in itself sufficient reason for some treatment which will conserve the material as well as improve the service to the public. Mr. B. C. Tiney, Maintenance Engineer of the Michigan State Highway Department, states in his discussion of the treatment of gravel roads: "It is desirable to treat all gravel roads carrying a daily traffic of 300 to 500 vehicles and I regard it as almost a necessity for traffic of more than 500." The State of Michigan treated over 1500 miles of their trunk line roads with Calcium Chloride last year and expect to increase this mileage considerably this year. Mr. N. M. Isabella, Maintenance Engineer of the Wisconsin Highway Department, recently stated that it would require at least 300 cu. yds. per mile per annum, and sometimes double that amount, of resurfacing material to maintain a gravel road carrying 500 or more

vehicles per day which had not received treatment, while if the road was treated with Calcium Chloride the amount of resurfacing material required would be reduced to 50 cu. yds., a saving of at least 250 cu. yds. of gravel per year. The ability of the Calcium Chloride to absorb and hold moisture makes it an ideal material on gravel roads to keep the fine material in a damp condition so as to properly bind the gravel and prevent dusting.

Before treating a gravel road with Calcium Chloride the surface should be brought to a uniform cross section. Loose gravel from ½ to 1 in. should be kept floating on the road so as to fill all depressions and maintain a smooth riding surface. It is recommended that one pound of Calcium Chloride per square yard be used for the first application followed by a second application of one-half pound per square yard when the condition of the road shows the need of treatment, probably from four to six weeks after the first application. It may also be necessary to make a third application when the traffic is fairly heavy. The amount of Calcium Chloride applied per square yard, as stated above, will insure proper treatment for the surface and will not cause excessive packing which forms a crust that will not be easily broken up and thereby permits holes and ruts to develop. The full wearing surface of the road should receive the treatment so that traffic will be uniformly distributed. If the material is applied as directed it will properly reduce the dust and at the same time give a smooth and satisfactory riding surface. Careful inspection of the road should be made frequently so that calcium chloride may be applied before any ravelling of the surface may occur, and that the benefit of the previous treatment may be conserved. Proper maintenance must be carried on throughout the entire season if the surface of the road is to be kept smooth and the greatest service obtained from the use of the Calcium Chloride.

A new gravel road will require heavier applications until the calcium chloride penetrates into the road, binding the loose gravel. The fact, that the calcium chloride penetrates into the road rather than remains on the surface, is of interest. Though there is no visible sign of the material it has its effect in properly maintaining the road surface.

The method of application is very simple and requires no costly equipment. The calcium chloride is carried on a truck from which it is transferred into an ordinary lime-drill or similar device which is attached behind the truck. The spreader should be kept full at all times as the same pressure assists in obtaining equal distribution. Though it does not require skilled labor to apply calcium chloride properly, care should be used in getting uniform distribution and that a correct amount be applied, according to the condition of the road surface. It is important that calcium chloride be applied at the time the road is in need of the treatment. If it is planned to apply direct from the car shipment should be made so that the material will arrive at the proper time.

The cost of calcium chloride treatment is about 3c per sq. yd. per year, or about $300 for the treatment of one mile of road per year. The use of calcium chloride can easily be justified when it is realized that the annual loss in material when figured at $2 per cu. yd. in place would amount to $600 or more per mile, which is far in excess of the cost of the treatment. Also this conservation of material is of particular importance, as some of the states have difficulty in finding sufficient local material for necessary maintenance with frequently none for new construction.

In addition to the saving in material there is the elimination of the dust nuisance, which is not only disagreeable and unsanitary, but is responsible for many highway accidents, and the decrease in the efficiency of the roads. When it is realized how great the mileage of gravel roads is in these states and when the conservation of material and elimination of dust is considered it is obvious that such a treatment is not only a true highway service, but a good business proposition.

Curing Concrete With Calcium Chloride

Research, together with recent practical tests, such as the Pittsburg Test Road and the Bates Test Road, has furnished us with information which permits the engineer to design a pavement with quite definite knowledge as to the strength of the concrete which will be required to meet the specifications. Many organizations, particularly the Portland Cement Association, have developed important facts regarding concrete. Their investigations have shown the benefit of careful practice, and that definite strength will be obtained if proper methods are followed out in the

manufacture of the concrete.

Chief among the factors controlling the strength of concrete is proper curing. Concrete must be furnished moisture to gain full strength, and under the old specifications this moisture was supposedly furnished by covering the pavement with dirt or straw which was to be wet. This method required much labor and was seldom properly carried out, that is, it was difficult to secure a uniform distribution of the covering material and constant supervision was required to be sure it was properly wetted. Also, it was often very unsatisfactory and expensive due to insufficient water supply or because it was necessary to maintain a pipe line for that purpose only. Finally, the removal of the dirt or straw always remained as an additional problem.

Due to these difficulties the Illinois Highway Division started an investigation in 1921 in an endeavor to find some other means of properly curing the concrete. Several materials and methods were used; among which was the covering with dirt on which was placed Calcium Chloride, the assumption being that Calcium Chloride would attract moisture from the atmosphere and by keeping the dirt wet would thereby take the place of ordinary wetting.

It was soon found that the moisture did not penetrate the thickness of the covering and as a result Calcium Chloride was applied directly on the surface of the concrete as soon as the concrete had set sufficiently to permit its distribution. Over two thousand test specimens were made in this investigation and it was definitely shown that concrete cured with a surface application of Calcium Chloride would gain the same strength in 14 days as concrete cured with wetted dirt would in 28 days. Several states have used the Calcium Chloride method of curing for thousands of miles of concrete pavements and field observations of these pavements check the tests as made in the laboratory.

It was of importance then to ascertain whether concrete cured by this method would withstand traffic wear as well as dirt cured concrete.

In order to determine this fact the department cast several concrete slabs, curing some with calcium chloride applied on the surface and some with dirt which was kept wet. These specimens were tested at various intervals of age in a machine designed especially to approximate the wear on a concrete pavement.

The specimen was clamped to the frame of the apparatus and wear was caused by the abrasion of two metal weights kept in circular motion. A constant flow of standard abrasive material preceded the weights so that an abrasive wear was caused on all of the concrete specimens to show the comparative wearing qualities of concrete cured by the different methods.

The results of these tests show that the wear on the specimen (7 days old) cured with Calcium Chloride was considerably less than the wear on the concrete cured with a covering of dirt kept wet. The compression and traverse tests, made in conjunction with the determination of wear as checks on the quality of the concrete used, showed the concrete cured with Calcium Chloride much stronger than that cured with the dirt.

The use of Calcium Chloride as a curing agent insures uniform curing and does not require the length of time required under the old methods. It is entirely completed when the calcium has been uniformly spread over the surface of the concrete and does not require further attention such as the continual wetting and the removal of the material as is necessary with dirt curing.

Calcium Chloride Incorporated in the Concrete

It has long been known that the incorporation of calcium chloride in the concrete mix will assist in obtaining early setting. It is only recently that its value when incorporated in the mix as a curing agent has been realized. The same amount of calcium chloride with different cements does not always cause the same degree of accelerations, but experiments show that 2 per cent by weight of the cement is always sufficient to effect satisfactory curing as compared to that of wetted earth or straw.

One of the most important facts concerning calcium chloride used integrally as a curing agent is the early strength gained in the first few hours. This is very important, as it allows the concrete to resist internal stresses which may be set up by temperature and moisture changes which may be as great soon after placing the concrete as would occur a year later and yet under ordinary conditions the concrete has little strength to resist these stresses. Also, due to the ability of calcium chloride to hold the moisture in the concrete the volume is

kept nearly constant, during setting, and the stresses set up due to contraction under ordinary curing conditions are minimized.

It is due to these stresses that cracks are formed during the early curing period of the concrete and it is these cracks requiring maintenance which offer weak points that shorten the life of the pavement. The use of calcium chloride integrally materially increases the early strength of the concrete so as to more successfully resist these stresses and thereby reduces the number of transverse cracks.

Satisfactory apparatus has been developed for incorporating a solution of calcium chloride so that it is definitely insured that the proper amount is being added at the proper time to the concrete mix.

The curing of the concrete by the incorporation of calcium chloride not only insures uniform curing throughout the mass of concrete, but is labor saving, as it requires but one man to carry on the curing. No covering or other curing is needed except during the summer months, when wetted burlap should be placed immediately on the concrete.

To Secure Maximum Acceleration By the Incorporation of Calcium Chloride In the Mix

When it is desired to secure as early strength of the pavement concrete as possible, it is advisable to make specimens of the concrete mortar using various percentages (from 2 to 4 per cent), of Calcium Chloride by weight of cement and determining the comparative strength of the specimens to ascertain the calcium chloride carrying capacity of that particular cement. This will indicate the percentage of calcium chloride which should be used, and to be confirmed by field tests made to determine the strength of the concrete under the actual conditions. The pavement may be opened to traffic as soon as sufficient strength has been gained as required by the design formula.

The early strength obtained by adding calcium chloride to the concrete mix is undoubtedly due to the ability of the calcium choride to hold moisture, but it has so far been difficult to ascertain its reaction due to the lack of knowledge regarding the setting and hardening of cement. However, physical tests have definitely proven its value both as a curing agent and accelerator.

Opening of Pavements to Traffic

There had been considerable discussion as to what the matured strength of concrete should be for pavements, but that discussion has dealt with the pavements under the most adverse conditions, that is:

When the slab may not receive any definite subgrade support, as is probable the case when the frost is leaving the ground in sections having a subgrade which holds a large per cent of moisture.

When the traffic consists of a large number of heavy vehicles, which might cause fatigue. When the loads are applied directly on free corners of the slab formed by the occurrence of transverse cracks due to temperature changes.

But there has been very little discussion as to what the strength of the concrete should be under the conditions at the time of opening a new pavement. There are many conditions which exist during the early curing of a concrete pavement which are factors of safety so that when the strength of the concrete in the road has reached the unit working stress in the formula for design it is safe to subject it to the loads considered. It is therefore not necessary to use a factor to take care of possible fatigue, etc.

The slab would, without question, receive considerable subgrade support for at least a period long enough for the concrete to gain its full strength.

It is probable traffic would not reach a point such as to cause fatigue. Light loads, such as pleasure vehicles, which do not stress the concrete beyond 50 per cent of the modulus of rupture will not be a contributing cause for fatigue.

Obstructions may be placed along the edge of the slab so that the loads would not be applied directly on a free corner, at the edge of the pavement.

When dowel bars are used across construction joints free corners would be eliminated, for the dowels should function perfectly, especially when the pavement is new.

All of these factors serve as measures of safety against nonuniform concrete or other conditions affecting the uniform strength of pavement.

Therefore, if the cross bending strength of concrete specimens which are made of the same concrete as the pavement slab and cured under exactly the same conditions as the concrete in the pavement, is determined at various ages, it is en-

tirely safe to open the road to traffic as soon as the concrete has attained a strength sufficient to support the maximum load which is to be permitted on the pavement. Especially should this matter receive attention when the inconvenience and the cost to the public is taken into account.

There is no more reason to prohibit traffic from using this pavement under the above conditions than to refuse to permit the maximum load on the pavement which was considered in designing for the quality and thickness of the slab.

A simple cantilever method of test has come into quite general use in determining the cross bending strength of concrete.

The machine consists of an extension arm which may be fastened to the free end of a specimem beam which is half in cantilever. The load is then applied by pouring some free running material at a uniform rate into a container which is fastened to the end of the cantilever arm. This simple method of test has made possible field testing which required little labor and expense and gives results which are directly indicative of the true strength of the pavement concrete.

For this purpose test beams are made in forms from the same mix as used in the pavement. These specimens are allowed to cure under the same conditions as the pavement concrete and are broken at regular intervals in the field with this simple testing device.

The specimens may be held in cantilever by clamping to the rear end of a truck or other improvised platform. The loading medium can be water which may be measured and the load thus determined so that scales will not be required on the job.

A very satisfactory frame work for holding the specimens and by means of which the load may be applied and measured with a dynamometer has been devised by the Testing Department of the Tennessee Highway Department. This machine has proven very convenient and very satisfactory for use in the field. Care should be used to be sure that the dynamometer is properly calibrated, and that the load is uniformly applied so as not to cause the effect of impact or fatigue while testing.

The advantages of this test as compared to the former method of determining the compression strength are:

The saving in cost and time, as the apparatus necessary to make the test will cost but a few dollars and may be assembled in the field.

That the method will give more uniform results due to the manner of testing.

That the specimens may be tested in the field and therefore the concrete is tested under exactly the same conditions as those existing in the road slab.

The cross bending strength is determined rather than the compression strength which is not necessarily indicative of the resistance against cross bending, the manner in which concrete pavements fail.

The practice of making these tests in the field and opening the pavements to the public as soon as the concrete has increased in strength to that used in the design formula is being adopted by many State Highway Departments.

On most public highways at least 90% of the traffic consists of light weight traffic, such as pleasure vehicles, etc. This class of traffic should not be held from the pavement until sufficient strength is reached in the concrete to carry the heavy truck loads. It would certainly seem advisable to expend what may be required to properly police the road so as to make it satisfactory to allow the light traffic to use the pavement for which the strength is fully adequate and preclude the heavy traffic which might cause failure until the concrete has gained greater strength. A determination of the saving which will result to the public in being allowed to use the concrete surface rather than being required to use the provided detour for even a short time will prove the importance of this matter.

When Calcium Chloride is incorporated in the concrete mix much earlier strength may be obtained and if tests are made in the field to determine just when sufficient strength has been ob-obtained pavements may be opened to traffic in a few days in place of three or four weeks.

Such a policy of opening roads indicates real advancement in highway construction practice.

ROAD EXPERIMENTS BY THE UNIVERSITY OF ILLINOIS

By C. C. Wiley, Assistant Professor of Highway Engineering, University of Illinois, Urbana.

(Synopsis of address before the Annual Convention of the Indiana Sand and

Gravel Association, Dec. 15, 1926.)

As in other engineering work, basic information on the theory and economics of road building must be obtained from experiment and experience. Experience is a costly teacher and requires a great length of time to attain results. Experiment is therefore the direct means of securing information in a short period of time.

All experimental work is expensive. Road experiments are, however, more expensive than many in other lines of work because of the fact that they must be made of full-size specimens and in their actual locations on the ground. This calls for a large volume of material and a large amount of labor, while the transportation to and from the propect is no small item. It is therefore often impossible or at least impracticable to undertake road experimentation on a scale that is commensurate with the importance of the problem or the value of the probable results. The Bates Road Experiments carried on a few years ago by the Illinois Division of Highways, cost roughly a third of a million dollars and yet were entirely justifiable because the money saved to the State of Illinois alone is many times this sum and when all of the states are considered the value of these experiments is almost incalculable.

Research work cannot be done by everyone nor in a haphazard manner. Certain habits and qualities of mind are required to do experimental work if the results are to be dependable and the program must be laid out in a definite and logical sequence if the results are to be of service. Experimental work at best requires a considerable amount of time, although much less than is required by the school of experience. First of all the problem must be formulated. Next the personnel must be selected. The work must then be organized and the actual work begun. Considerable time may be required to secure adequate data. Finally, the results must be coordinated, compared, interpreted, and the conclusions drawn, which cannot be done over night.

The first full-size experiments conducted by the University of Illinois were made on the oiling of earth roads, a process that is comparatively little used in Indiana but is of considerable magnitude and importance in the great mud belt of Central Illinois. For example, Champaign County, in which the University is situated, alone applies some two million gallons of oil to its earth roads each year while the State of Illinois as a whole applies some forty-five million gallons.

The results obtained from these first two experiments are reported in Circulars 10 and 11 of the Engineering Experiment Station. As an outgrowth of these experiments we received a letter from Mr. F. E. Jerome of the Austin Manufacturing Company of Chicago raising certain questions in regard to equipment and methods applicable to oiling roads and perhaps also applicable to gravel roads. After some correspondence this company agreed to finance two graduate research fellowships for a period of two years for the study of earth and gravel roads. In addition it agreed to furnish such road machinery as it manufactured as might be desired and also to pay for its operation.

With this much provided for it was next necessary to find places to operate, materials to use, and the necessary cooperation for the other factors involved in the tests as, unfortunately, the appropriations to the University do not contain items which give us funds to carry on this work of this kind without further help.

Our first step was to secure the necessary personnel or the appointment of two graduate research assistants. After some delay we first appointed Mr. J. E. Kerenan and a half year later Mr. A. H. Finlay. Mr. Kerenan could remain only one year with us so that at the end of this term M. C. F. Smith was obtained. These young men are all graduates of engineering schools and working for advanced degrees. We feel very fortunate in securing their services in this work.

The next step was to secure a suitable road upon which to work and the necessary cooperaton from the road officials. The territory immediately surrounding the University gave us all kinds of earth roads but nothing more, and no difficulty at all was experienced in securing the cooperation of Champaign County through the county superintendent of highways, Mr. R. F. Fisher. Not being able to find gravel roads close at hand it was necessary to call upon Mr. W. S. Dillon, county superintendent of highways of Vermillion County and after some reconnaissance we chose for our work a section of what is known as the Old Bismarck Road lying about six miles northeast of the City of Dan-

ville and immediately south of the village of Bismarck. Arrangeemnts were also made through Mr. Dillon for the active cooperation of Vermillion County.

The next step was to secure the necessary materials and it so happened that my good friend and former classmate, Mr. S. C. Hadden was secretary of your honored organization and therefore I felt perfectly at home. Through him and your good president, Mr. E. Guy Sutton, arrangements were made for the first lot of material necessary to start the work.

The section of road chosen for the gravel experiment is three miles in length. The southernmost mile which we designate Mile A was, at the time of beginning the work, an earth road in an abominable condition. For about a fourth of a mile it was periodically flooded by a drainage ditch which ran along the side. At another point, surface drainage crossed it instead of following the side ditch to an outlet. These places were impassable except during the summer. In another place, water had crossed the road and badly eroded it. The entire surface was flat and in bad condition. It was proposed to regrade this mile and then surface it with gravel in such a manner to make a study of different materials and different methods of placing them.

The second mile which we call Mile B was originally a gravel road but some 16 years ago received a surfacing of crushed limestone. We expected to do certain work on this road but with the limited facilities available and with the difficulty of securing the necessary materials we have done but little with it. Moreover, the local residents seemed to object to any attempt to disturb the road or to use gravel on it, hence it seemed expedient to leave it alone for the time being.

The third mile, known as Mile C, is a gravel road made in the old fashioned method by dumping bank-run material in irregular files down the middle of the road and letting it compact under the action of traffic, weather, and occasional grading work. This stretch of road actually extends three miles into the village of Bismarck but we took over only a single mile for our work.

This road was originally the main traveled road to the north of Danville but when paving State Route No. One, another route was chosen and this old road was neglected. The result was that for some five or six years it had received very meager attention and consequently had fallen into bad condition. We therefore looked upon the problem as one in rehabilitation or in returning the road to a usable condition with a minimum effort and cost.

The first part of the year 1925 was spent in making a survey of the road and in laying out the program. The Austin Manufacturing Company then shipped us one of their twelve-ton power rollers with scarifier and blade attachment and also one of their four ton combined roller, scarifier and blade machine built on a Fordson tractor and which they call the Austin Pup. These machines were received about the middle of May and the first work was done the latter part of that month.

As usual in roadwork we started our operations on the surface material, although it was obvious that regrading was necessary and that the drainage needed improving. Using a heavy roller we found it possible to scarify, reshape, and practically recompact the graveled surface into usable form in a very short time and at a small cost. It soon developed, however, that this road did not have sufficient material at all points to be placed in good condition. We therefore made arangements for the shipment of two cars of gravel, one of ordinary 1½ in. concrete aggregate and the other of pea gravel. These were received during the month of July. The road forces of Vermillion County unloaded these materials and spread them under our direction.

The section chosen for this first application was one where the old surface consisted of extremely fine gravel badly worn so that it rapidly cut into dust when dry and became mushy when wet. The surface was in generally good condition so we applied only a thin surface of gravel. A stretch of about 300 ft. was covered with pea gravel ranging in depth from a half inch to an inch. A stretch of about 150 ft. was covered with about 1 to 1¼ ins. of the coarser material. The remainder of the material was used in miscellaneous places.

The results obtained from the pea gravel application were truly remarkable. It was put down in dry weather and at a time when the entire traffic from State Route Number One was being detoured over the road on account of repairs to the pavement. Nevertheless this pea gravel began immediately to combine with the surface and with a little

blade work after the first rain this section became the best one on the entire road and at this time, after more than a year of service this stretch is one of the best on the road.

The same could not be said of the coarse gravel. The coarse particles did not penetrate and combine with the old surface, with the result that for a long time loose stone were present on the surface and it has only been after a process of regrading that this section has become satisfactory. Note, however, that this applies to surface application to an old road and not to the use of coarse gravel in the body of new work.

With the coming of fall weather it became evident as was expected and we wished to demonstrate that drainage conditions of the road needed attention before satisfactory surface results could be obtained. Therefore late in the fall of 1925 and the early spring of 1926 the entire road was regraded, ditches opened up, and culverts put into serviceable condition. This was all done by the road forces of Vermillion County and at the county's expense but under our supervision.

During the season of 1926 much work has been done on the surface. Pea gravel has been used almost exclusively on this work and it has been applied in depths ranging from 1 to 6 ins. It has been the experience in many states and is definitely borne out by our experiments that the best results are obtained in applying gravel in courses of not more than 2 ins. at a time. This plan has been followed in this work except for a few isolated trials at greater depth.

At the present time Mile C is in excellent condition. The original surface was reshaped to give a proper crown and a running width of about sixteen to eighteen feet. The weak places have been strengthened by additional gravel and those parts of the surface which were not standing up under the wear of traffic but which supported the load, have been given a thin application of pea gravel. This mile can be traveled at any reasonable speed and in entire comfort and we believe that it is in good condition to withstand the winter.

While this work was in progress on Mile C, Vermillion County entirely regraded Mile A and the drainage ditch along one side was widened and deepened. The grade of the road was built up as high as available material would permit and brought to a good cross-section. Where the road had been eroded it was regraded and brought again to a standard cross-section and in the same way the mud holes were eradicated. It was found that a large tile crossed at one of these points. Originally, inlets had been provided but these had become obstructed. New catchbasins with new covers were built and up to this time the surplus water has been carried away and this part of the road is rapidly consolidating.

The results we obtained with pea gravel have been more than satisfactory and by comparing them with gravel roads in Michigan, Wisconsin, and Minnesota, we find that the universal opinion is that the best surface for motor traffic is that made up of materials smaller than ¾ in. The bank-run materials which we have used, have not been entirely satisfactory. Almost invariably they contain too much sand and large fragments of rock which are objectionable under motor traffic. However, these bank-run materials can be used by screening out the large fragments and after partially compacted, giving a surface dressing of pea gravel. We have used some screened gravel in the lower courses and the indications are that if the subgrade is at all soft or spongy, that this is advisable.

The experiments on oiled earth are not of special interest to this assembly except in one particular. A number of counties have considerable mileage of narrow pavements of brick or concrete with earth shoulders. These earth shoulders present a problem in maintenance, especially in the winter and rainy seasons. Mr. R. F. Fisher, county superintendent of highways of Champaign County, has been much interested in the possibility of holding these shoulders with oil and gravel. The earth road we selected for experimentation extended from the end of a three-quarter mile section of 9 ft. concrete pavement laid with its edge on the center line of the road. This shoulder was treated first with an application of about a half gallon of road oil per square yard and then covered with sand or gravel. Sand was used for about half the distances, ranging from a bare covering to about half an inch in depth while pea gravel was used in a similar fashion over the remainder of the distance. One or two short sections received a second application of oil on top of the gravel and a light sprinkling of gravel in addition.

Surfacing of the road was begun with

a bank-run material of rather questionable quality obtained from a local pit. This material was donated by Newell Township. In addition, gravel supplied by members of this Association amounting to about 20 carloads was obtained. The majority of this was pea gravel but there were a few cars of mixed road gravel and one or two cars of screened concrete aggregate. The county forces did not appreciate the magnitude of the whole problem and therefore the process of applying this gravel has proceeded quite slowly and the large amount of rain in the early fall has sadly hindered us in getting the gravel on the road. Foreseeing that the county forces could not distribute rapidly enough I applied to the Illinois Highway Department and received aid from them in the form of a five-ton truck which has done yeoman service in putting this gravel on the road, so that at the present time the surfacing is as nearly completed as can be accomplished under the existing conditions. All of this mile has received a surfacing of some kind. Some of it may withstand the winter, some of it surely will, while some of it probably will not.

In the fall of 1925 we held a meeting of the interested parties in Daville and visited the road. Several members of this organization were present and offered helpful suggestions and criticisms. Again this fall we held a similar meeting with similar results and I can sincerely say that the success of experimentation of this kind depends on the cooperation of all of the interested parties and especially in the exchange of ideas, suggestions, and criticisms. The status of the experiments are of course just at the point where we can just begin to draw definite conclusions. We believe that there is a wide field for the use of pea gravel in the rehabilitation of existing gravel roads and in their maintenance.

In addition to this shoulder we have short sections of 100 to 200 ft. in the oiled road itself receiving a cover of gravel or sand. Up to date these sections are decidedly superior to the oiled sections adjacent to them which have not had the covering. The sections with gravel appear superior to those with sand, which is also the indication along the pavement shoulder. Of course it is too early as yet to be sure of what the results will be as we must wait until next summer and the adverse climatic and traffic conditions of winter have tried out this work. However, we are inclined to believe that the gravel covering is a decided advantage and it remains to be seen whether the cost will be within reach. Incidentally, it seems to make little difference on the oiled road whether the gravel is applied immediately after the oiling or whether two or three days elapse.

As stated before, these experiments are just in the stage where we can begin to obtain definite conclusions. The test of the winter season followed by that of summer and, if possible additional work through another winter should be had to really make the conclusions positive. To accomplish this means that we must continue in the cordial relations of cooperation that have obtained during the past year and a half. On behalf of the University I wish to express our appreciation of the deep interest and wholehearted cooperation given us by the Indiana Sand and Gravel Association and the personal interest shown by a number of the members. We are also indebted to the other parties cooperating, namely, The Austin Manufacturing Company, Vermillion County, Champaign County, Newell Township, and the Illinois Highway Department. In addition we have received some small assistance and have the promise of further aid from the National Lime Association in the matter of lime treatment of soils and from the Solvay Process Company, who have promised us a carload of their Calcium Chloride for surface treatments.

SUPER-HIGHWAYS IN DETROIT REGION

By Edward N. Hines, County Road Commissioner, Wayne County, Detroit, Mich.

No part of the country has done so much to clutter up our roads as has the territory around Detroit. And as if to pay for the vexing traffic problems which it has thrust upon other communities Wayne County, in which Detroit is located, has taken the lead in solving highway tangles. The first Wayne County Board of Road Commissioners, of which I was a member, was created in 1906. Three years later we adopted concrete as our standard pavement and have built practically nothing else since then. In those days the idea of paving country roads was new and concrete was a new material for road surfacing so that Wayne County had little precedent to follow and became a pioneer in road matters. It is an even greater pioneer to-

day for, with the cooperation of Macomb and Oakland counties, the Detroit Rapid Transit Commission and the State of Michigan it has not only planned but is constructing the most comprehensive suburban thoroughfares the world has ever seen.

Back in 1906, one of the first acts of the newly appointed road commission was to lay out a system of highways and plan their improvement. This plan has been rigidly followed. The original 350 miles of roads in the system has been built as well as 120 additional miles, concreted to meet conditions which arose later. In the beginning the demand was for mileage and the commission built many 12, 15 and 16 ft. pavements as well as considerable 18 ft. widths when it would have preferred to make 18 ft. the minimum width. When this construction work began there was no thought of the swarm of motor vehicles which crowd our highways today. The automobile was looked upon as a toy or a foolish luxury and motor trucks were hardly known. Had anyone prophesied that in 20 years there would be one motor vehicle for every three persons in Wayne County or dared to suggest the plan which is now being carried out he would have been accused of owning an opium pipe or, at the very least, of having the fantastic imagination of Baron Munchausen.

But traffic increased enormously. In 1912, for example Grand River Road carried an average of 1,082 vehicles a day, and by 1925 the daily count had increased to the remarkable average of 36,221 vehicles. This increase made wider pavements necessary. At first we increased our widths of pavement to 20 ft. of concrete, and increased the width of bridges to 27 ft. Later we set 40 ft. as the ultimate minimum width for pavements and bridges; and still many of our highways were overtaxed. Now we have planned and are building, a little at a time, a system of super highways which should solve our traffic problems for all time. The super highways have been laid out to serve the territory within 15 miles of Detroit. They form a checkerboard of roads and radiating, diagonal highways connecting with important city streets. The radial main arteries will have a width between fences of 204 ft. and at three mile intervals in the rectangular system there will be a highway with the same width of right-of-way. At each mile interval between the three mile roads there will be a road built upon a 120 ft. right-of-way. On half mile lines the right-of-way will be 86 ft. wide.

Half mile or 86 ft. roads will carry two pavements, each 20 ft. wide, separated by a 20 ft. strip which may be used for interurban tracks or for future additional concrete. The remaining 26 ft. will provide a 13-ft. strip on either side for walks and parkways.

On the 120 ft. right-of-way there will be three pavements—a central strip 40 ft. wide for two-way, highspeed traffic, separated from two 20 ft. one-way traffic lanes by a 5-ft. parking strip. Along the sides there will be a 15-ft. space for shrubbery and walks.

The 204 ft. roads will be different from anything now in existence. An 84-ft. center strip will be occupied by four rapid transit tracks which will be an extension of the subways planned for the already built-up sections. The tracks will be lined with shrubbery which will screen them from the road and will be fenced to bar trespassers. On each side of the track zone there will be a one-way pavement 20 ft. wide for high-speed traffic and outside of that, separated from it by a 5-ft. strip of grass or shrubbery, another 20-ft. pavement for slow traffic. That will leave two 15-ft. margins for sidewalks and parkways.

Eventually no pedestrians or traffic of any sort will cross the tracks or high-speed lanes. Where 204-ft. highways intersect, the roadways will be separated into three levels. The local traffic lanes will be carried at the elevation of the adjacent property; the tracks and high-speed pavement of one road will cross above the local level and the other below it. Where the 204-ft. highways intersect the 120 and 86-ft. roads there will be a two-level crossing at which the tracks and accompanying high-speed pavement of the wide road cross above the narrower highways and the local traffic lanes meet them. Rapid transit stations will be located at these intersections with stairways leading to the local level so that no pedestrian ever need cross the high-speed motor lanes.

The 204-ft. highways will be narrowed to a width of 120 ft. when they reach the present built-up city area. The high-speed and local traffic lanes will remain the same width but the 84-ft. central zone will be eliminated by running the tracks underground. Bringing the subways to the surface in the suburban area where right-of-way can still be se-

cured will save at least $2,000,000 a mile in construction costs. That means that these districts can have rapid transit service earlier or can have more trackage for their money.

The state is cooperating by making its routes, within the Detroit area, conform to the super-highway plan. Already they have secured a 200-ft. right-of-way on the extension of Woodward Avenue from Detroit to Pontiac, a distance of 15 miles, and have laid two one-way concrete pavements each 45 ft. wide. It was the traffic relief afforded by these wide pavements which sold the super highway plan permanently to the people.

Within the city the Detroit Rapid Transit Commission is carrying out its share of the plan. Fortunately Detroit has some 100, 105 and 106 ft. streets and those which have good alignment, continuity, location and connection with the outside routes have been chosen for super highways. On these it is planned to have the building lines set back from 7 to 10 ft. on a side to make them conform to the new 120 ft. width. The present average life of buildings in rapidly growing cities is about 33 years. When new buildings are erected they will be set back to the new building line. Those outside this line when final widening takes place will be condemned to the width desired.

At present the efforts of everyone concerned are centered on securing the necessary right-of-way. There is no great present need for the full width highways planned, but every dollar spent in getting right-of-way before the land is subdivided and built up will save many future dollars. Real estate firms, individual property owners and village boards have cooperated with us in nearly every instance, often donating the necessary land or selling it at a nominal price. After the right-of-way is secured we can build the pavements necessary for our present traffic and add the other trafficways as they are needed. At present two 20-ft. and a considerable mileage of even wider widths of pavements have been built on several roads and more are planned for construction in 1927.

Big as the task is, Wayne County is not expending all its energy on super highways. Tree planting and landscaping are going forward, grade separation to eliminate dangerous railroad crossings is an important part of our construction work, and roadside comfort stations, county parks and playgrounds are a part of our program.

Already 21 grade crossings have been eliminated and plans are on foot for further safety measures of the same sort. Adequate highway marking also adds to the pleasure and safety of those many strangers who annually use our roads. At every intersection ornamental signs give distances and destinations in each direction. No one but the county is allowed to put sign-boards of any sort within the right-of-way.

In our tree planting whatever of beauty there is along the roadside is saved and if possible enhanced. The county forester directs planting and maintenance. Existing trees are saved and maintained by experts, grass and weeds along the right of way are cut, and the banks of cuts and fills are planted with grass, vines, shrubs and flowers.

The county has also provided many conveniences for picnic parties and tourists. There are five county parks equipped with playgrounds, tables, stoves, running water, and every requirement for a day's outing. Eleven modern comfort stations have been built in the parks and at convenient locations along the roads. Each of these is in charge of a caretaker. There is also a "Tourist Lodge" which has been pronounced the finest camp in the United States. The Lodge itself is an attractive brick building containing a lounge and writing room, tourist dining room seating 44 people and a service room where hot coffee, sandwiches, ice cream and groceries are for sale.

Wayne County has much to be proud of and best of all, to us, is our position as a forward looking community. Our sons and our grandsons will remember us with pride when the people of other communities are paying high prices for the land they must have to relieve the stranglehold which poor transportation facilities will have clamped on their older portions of the city.

HIGHWAY PLANNING IN CALIFORNIA

(From "California Highways.")

California is faced with the problem of expanding the state highways laterally as well as longitudinally. Not only are our pavements narrow, but we are in possession of thousands of miles of narrow right of way, 60 ft. or less in

width. Residents of the counties which have heavy intercity traffic know of the inadequacy of the pavement and roadbed widths, and of the program of widening which the state has under way. They can see the territory adjacent to these highways gradually losing its character as open farming land, surrounded by barb wire fences, beyond which is heard each season the hum of the mower and thresher.

The change taking place is the gradual settling up of the land by the additional population flowing into the state, and the expansion of towns to include more territory. The red and yellow flags of the subdivider float in the breeze along miles of landscape, the forerunner of more homes, business buildings and other intensive improvements. Each flag means a new family, a new dwelling, a new garage and another automobile. Each automobile means more traffic on the highways.

Influence on Highways.

There is not a county in the Sacramento and San Joaquin valleys nor along the coast where the above description is not applicable. Do we realize what this means to the state and the county highway system?

Due to the wise, limitations of the law enacting the present gas tax, the State Highway Commission has, since 1923, been engaging actively in the widening and reconstruction of state highways. Much of this work has been concentrated around those centers of population where traffic has already overrun the previously built improvements. Therefore, the state's engineers are acutely aware of the changing status of our agricultural land. We have seen many miles of state highways change in character from rural roads to city streets.

The realization that this change is taking place more or less rapidly adjacent to many of our highways, resulted last year in the initiation of a study by our department to establish ultimate widths for each mile of state highway. This study is already bearing fruit, and we are beginning to crystallize our ideas in various locations as to what the state highway will have to be ten to fifteen years hence.

Wider Rights of Way Needed

The main feature of this study, in so far as the present discussion is concerned, is that we know definitely that a 60-ft. right of way will be insufficient to carry state highway traffic. Many of our main highways should ultimately have not less than 56 ft. of pavement and probably they will be curbed and guttered. On a 60-ft. right of way, this leaves two feet on each side for the placing of power and telephone poles, trees and sidewalks. This is impossible on 60 ft. Therefore, we have determined that an 80-ft. width of right of way is the least which should be accepted by the state. In many locations, a greater width should be acquired.

This brings us to another angle of the matter—that is, the use made of the land adjacent to our 60-ft. right of way.

The red and yellow flags of the subdividers are a trouble signal to the highway officials. At the 1925 session of the legislature, we endeavored to have passed an amendment to the subdivision act which would make it mandatory upon those subdividing land fronting on a state highway to obtain the approval of the State Highway Engineer prior to the filing of the map with the county board of supervisors. This bill was lost in the legislative shuffle, and never became a law.

We therefore launched a program of soliciting the cooperation of the boards of supervisors in aiding us to safeguard the future of the state highways by refusing to accept for filing maps of subdivisions fronting on a state highway, which had not been previously approved by the highway commission. Every county board was notified of this desire on the part of the highway commission, and we asked each county board to pass an appropriate resolution agreeing to such a procedure. We are glad to state that many of the counties, during 1925 and 1926, passed such resolutions, and, as a result, we have made considerable progress in obtaining the necessary increased width opposite subdivisions.

However, the situation is not always one that can be handled simply by an expression of desire on the part of the board of supervisors or on the part of the highway commission. While most subdividers are willing and anxious to cooperate with the officials who have to approve their maps, yet occasionally one is encountered who resents the interference. He is interested only in getting his map filed, and legally, he may be entitled to it. When an array of legal talent tells the board what their duty is, and when the district attorney can not advise the board otherwise, the supervisors are up against a hard question in

refusing to accept subdivision plats for filing.

The section south of the Tehachapi does not have all the subdivisions; land adjacent to the state highways is being subdivided and sold everywhere, even in the remote northern sections. Only recently an active subdivider was able to convince a northern board that legally he was entitled to have his map filed. The state will probably have to take drastic steps in this case to obtain title to the land needed for widening the highway before the lots pass into the hands of a hundred different owners, and become built up with business blocks.

The commission is trying to develop a plan for the whole State of California. The relocation, realignment and widening features of our state highways all are a part of a magnificent scheme of boulevards which will gradually be finished and turned over to the traffic of California motorists and visitors from without the state, and to commercial vehicle traffic which is of increasing importance from the development standpoint.

Planning for the Future

California cities are spending thousands of dollars for expert advice to secure plans for their future orderly growth and expansion. And in working out these plans one of the most difficult problems encountered is adequate provision for handling traffic—the problem of the motor vehicle. Millions of dollars are being expended for the widening of streets and boulevards, much of which could have been saved by a little systematic planning a few years ago.

But the cities are not alone in realizing the necessity for planning future development. We have county planning commissions and regional planning commissions, such as the organizations now functioning in Los Angeles and vicinity and in the bay district. It is but a step farther to an adequate state-wide traffic plan. Without realizing it, the highway commission has had forced upon it the duty of developing such a plan. But it is without adequate authority of law to properly undertake the responsibility. The urban centers are not the only areas in the state with traffic problems; every trunk line highway in California is carrying an ever increasing volume of traffic which must be cared for. Due regard for the future welfare of the state, demands that we begin now to plan for the future of the highways as a state-wide traffic system. Delay means needless burdens upon the taxpayers of the future.

In proposing a legislative measure, to facilitate securing of adequate rights of way, it is not the intention of the commission or its officials to confiscate land. The state and the counties are willing and able to pay where damage is done. In nine cases out of ten, the subdividers themselves see the financial self advantage of setting aside the width necessary to make a wide boulevard past their property. We will take our chances with the subdividers on the question of payment for the land involved and it will never be the policy of the state to strongarm anybody into donating right of way at a personal loss.

Accomplishments in this direction can already be seen in many counties. In San Luis Obispo County north of Pismo is an example of what has been done through the cooperation of the board of supervisors, our division engineer, and the subdivider. On the section between San Jose and San Francisco, in both Santa Clara and San Mateo counties, are several examples of provision being made by the subdividers for a future wide boulevard. On the Ventura boulevard north of Hollywood in Los Angeles County for long stretches we are not only cooperating with the subdividers in the setting aside of land for a wider street, but we have agreed to defray a certain portion of the street building cost, whenever the abutting property is organized to handle their share. Similar examples are found in San Diego County between San Diego and El Cajon.

We take the progress which has been made in this regard without express authority of law as evidence of the understanding of the boards of supervisors of the necessity for a state-wide boulevard plan, and as an example of what can be accomplished in this direction through cooperative efforts of public bodies.

The burden in this matter should not be carried by the boards of supervisors. We believe it to be highly desirable that proper laws be enacted which will place on the subdivider the burden of conforming to the plans for ultimate development formulated by the State Highway Commission.

Almost every growing town in the state has felt the necessity of a coordinated plan for city development. Why should not the state and the counties

have a coordinated plan for highway traffic development? We have city and county planning, why not state planning?

INSURING MUNICIPALLY OWNED PROPERTY

By Ernest A. Paviour, Before Governmental Research Conference.

Stock company insurance is a method of distributing the cost of a sudden disaster over a wide territory. When San Francisco burned, the insurance companies—both United States and foreign—paid out more than $200,000,000 in losses from premiums collected on fire insurance policies in all parts of the world. We all helped to rebuild San Francisco. When you pay your next $25.00 premium for $5,000 fire insurance on your house, you are making a contribution toward the rebuilding of the next destroyed city. It may be your own; it may be Buffalo.

A company that does a limited business in a small territory is not as safe as a company that transacts business throughout the nation. Imagine a company organized to insure nothing but Rochester property. If Rochester is visited by a sweeping conflagration that company may be called upon to pay a loss under every policy on its books. Under the same disaster the stock corporation engaged in nation-wide insurance will find only a relatively small part of its total business affected.

When a municipality insures "its own propery" it is comparable to a small local company which could easily be wiped out on a single conflagration.

The head of one of the large stock fire insurance companies told me recently that a sweeping conflagration could visit any American city and his company, after paying all its losses 100 cents on a dollar, would remain solvent. And this company writes policies of hundreds of thousands of dollars on single, desirable risks.

How a company pays its routine small losses means but little. What did it do in Chicago, San Francisco, Baltimore? What will it be able to do when the next great American city is leveled by fire? The conflagration is the real test of an insurance company.

Some cities which do not carry insurance in stock companies tabulate their fire losses for a few normal years and then, on the basis of these, come to the false conclusion that they are ahead of the game. They ignore the sweeping fire —the nightmare of the true underwriter. Most any of us could pay for a burned curtain or a hole in the roof, but most of us couldn't survive the total loss of our house, contents, garage and automobile. Any plan of fire insurance that does not contemplate the conflagration is extremely faulty and open to disastrous consequences.

It is bad enough for a municipality to "carry its own insurance" by setting up annually grossly inadequate reserves. But it is much worse for a city to "carry its own insurance'" by setting up nothing. Take a city of the latter class, for example. It loses by fire a $400,000 high school at time when its finances are in such condition that it can't even build badly needed new high schools. It is true that it can say to the taxpayers: "We have saved you thousands of dollars during the last ten years by our policy of not insuring the schools." But that won't finance the rebuilding of the school. If a big section of the city is flame-swept and six or eight city-owned buildings are destroyed it will be even more difficult to explain satisfactorily the lack of insurance protection.

This system in which the taxpayers pay the fire losses has another inherent weakness. Cities operate under budgets which are invariably inadequte. A much used building with its equipment is destroyed. There is no insurance fund; there is no provision of any kind to underwrite fire losses. The work of the city requires immediate replacement of the destroyed building. This means that something else must suffer, something else must be curtailed, for departmental budgets aren't sufficiently elastic to permit the removal of $200,000 or $300,000 without a disturbance. If the destroyed property is replaced by a bond issue the interest paid on the bonds may be more than the annual insurance premium on all the city property.

The building up of an adequate insurance fund by a municipality is a slow ordeal. Insurance funds can't be magically organized. Of course a giant corporation with property widely scattered is in much better condition than an average city to establish a fund. This is true from the standpoint of the conflagration hazard, already described and the investment hazard, which will be touched upon later.

The premiums paid to stock companies for fire insurance represent but a small fraction of the amounts of the policies.

In some cases the rate is one-tenth or even one-twentieth, of one per cent. Some fire-resistive schools are written for ten cents for $100 of insurance. Do you realize what this means? At ten cents per $100, the cost of insuring a public building for $400,000 is only $400 per year.

Even if a municipality should put away the entire stock company premium on this risk annually, it would require one thousand years of premiums to equal the amount of insurance. If the fire occurs at the end of the first year the municipality is just 999 years behind schedule. It has a $400,000 loss on its hands with $400 in the bank. Under the same conditions the stock company has available millions of surplus painstakingly gathered from all sections of the country over a period perhaps of one hundred years.

Another disadvantage of municipal insurance funds is the manner in which the investment end of the fund is handled. In recent years the stock companies have not made anything on underwriting. They are paying out more in losses and expenses than they are collecting in premiums. Last year, more than 200 companies reporting to the National Board of Fire Underwriters lost $40,000,000 on underwriting. They did, however, succeed in making a fair return on investments. Successful insurance companies must be good bankers. Some single stock companies have investment lists of $40,000,000 and $50,000,000. These lists are large enough to warrant the establishment of an investment department under the management of a high-grade financier.

The investments of a small municipal insurance fund are likely to be in the hands of a part-timer—of the comptroller, or the treasurer,—who has many other duties. He is not in a position to give expert attention to the investment of the fund. If fire doesn't wipe out the fund, the stock or bond market may do it.

Raymond N. Ball, treasurer of the University of Rochester, who handles a list of $35,000,000, recently made a trip to Hartford to study the investment bureau of one of the insurance groups. This is his comment:

"Thank you for making it possible for men to visit in Hartford the investment bureau which handles investments of Phoenix and associated companies. This problem of investment of funds is such a complicated one today that I find myself taking every opportunity to learn how the other fellow is attempting to solve it.

"There are several reasons why we follow with keen interest the investments of the different insurance companies. Over a long period of years the losses of the better companies have been very small. The protection of their lists by proper diversification is given thorough consideration.

"Each issue, before purchase, is most carefully investigated. Once a security is purchased, it is watched closely. Experts who are trained in the business of buying and selling securities are in active charge of the lists. Public reports of holdings are available to policy holders.

"The business of investment of funds in any organization can not be handled as a side line. It must be handled by a separate department and by men who have made a study of investments.

"I was not disappointed in the Hartford Bureau. It is doing a splendid piece of work."

Whereas the municipality confines its insurance operations to one city, the stock company not only distributes its liability over the entire nation but reduces its liability in various sections of a given city to practical maximums. A stock company issues a policy for $50,000 on a brick mercantile building on Main Street, Rochester, in the conflagration area. It is true that the insured receives a single policy in a single company for $50,000, but that company does not retain that amount of liability. Here is what happens:

The agent wires his company that he has bound $50,000 on a particular risk. On receipt of the binder the home office retains $20,000 net for its fleet of three companies. in this particular case. (All of the big stock companies are now working in fleets—one outstanding company owns three or four smaller concerns.) Another $20,000 goes to the Reinsurance Clearing House, which is a group of eighty regularly admitted companies. The last $10,000 is taken by The American Reinsurance Exchange, another group of twenty companies. In other words, just as soon as the agent binds the $50,000, one hundred big stock companies with enormous resources are back of the company which actually issues the policy.

Million dollars fire insurance policies are not infrequent, and under this system of distribution and reinsurance they

are perfectly safe. Several of the stock company fleets have combined assets of more than one hundred million dollars. This doesn't mean that stock companies will write large amounts on any kind of risk. Companies often turn down what looks like desirable business simply because the rate as produced by schedule isn't adequate from their standpoint. Moral risk is another important feature of underwriting. If the physical conditions are good but the moral ownership bad, the stock company doesn't want the business. Location is another underwriting factor. A company may write $100,000 on a hospital under the protection of municipal fire department and water works, and refuse $1,000 on a frame summer concession at some lake resort.

A municipal fund loses the service of the local insurance agent, the home office inspectors and various rating and inspection bureaus. These services often result in the correction of bad fire hazards. They have saved many buildings from bad losses and many cities from serious fires. Competition amongst companies and agents results in constant attempts to reduce rates in order to hold business and get new risks.

Under schedule rating, charges may be removed if faults are remedied and credits may be obtained for improvements. The rate measures the risk. A cut-off wall here, a standard fire-door there or a safety can somewhere else will cut down the rate and fire hazard at the same time. Agents are ever watching for these and other opportunities to lower rates. (By agent, I mean the full-time insurance agent, not the parasitical part-timer who doesn't know an insurance schedule from a telephone directory.)

In Rocester in the last year or two scores and scores of business basements have been cleaned up, hundreds of defects in heating and other devices corrected, and thousands of chemical extinguishers installed in factory and store —all on account of the efforts of agents to eliminate hazards to reduce rates. Perhaps a conflagration has been averted. Who knows?

Uninsured public property doesn't get this careful scrutiny. But how it needs it! Public schools are burning daily all over the country. This is one of the unprofitable classes from an underwriting standpoint. A school valued at more than one million dollars was destroyed last year. Not only is the property consumed, but innocent children are slaughtered. In just four school fires more than 200 persons, mostly children, were killed. Thousands of school houses in this country were built to burn—poor construction, lack of fire protection, faulty heating devices, improper exits. This is another crime chargeable against the American city.

A municipal insurance fund has no opportunity of selection of risk, reduction of line by reinsurance and home office distribution, and spreading of liability over a large territory. It ignores the law of average. It ignores the conflagration hazard which is present in every American city. Little, if any, attention is ever given to the investment end of the fund, a matter of great importance. It sadly misses the beneficial hazard-reducing services of the stock insurance company.

Such a fund takes everything owned by the city as it is, regardless of constuction, location, exposure of protection. It lacks underwriting experience, sense and judgment, and finacial soundness, and belongs in the category of experimental socialism, far away from the realm of practical business.

The American city is suffering enough today without afflicting it with municipal insurance.

COMPACTING HIGHWAY FILLS BY JETTING

By Thomas H. Cutler, Engineer of Construction, Missouri State Highway Department, Jefferson City, Mo.

(Paper read at 1927 Meeting of American Road Builders' Association.)

Contractors and engineers have found it difficult to construct fills in horizontal layers and to thoroughly compact the fills so that they will be suitable for paving. In recent years, many experiments have been made with water jetting and large fills to hasten final settlement. I have used this method for many years in sandy soil, but doubted the efficiency of jetting fills composed of loam, clay, or rocky soil.

Results of Water Jetting

On 26 miles of work for which the grading and paving contracts were let at the same time, it was decided to see what could be done by jetting the large fills. All fills 4 ft. and over, except one, on this section of road, were jetted; the fill which was not jetted was 8 ft. in

height, and a failure occurred within 2 months after the pavement was laid on this particular fill. There was no sign of failure of the pavement due to settlement on any of the other fills that were jetted, even after a period of more than one year. There was, however, a slight settlement of one 5-ft. fill near a culvert. This fill was only 5 ft. deep for a short distance, and there was probably some negligence on the part of the jetting force. A number of 8-ft. fills and some 20-ft. fills have not settled during the last 2 years. At least, there is no noticeable defect in the concrete pavement that was laid soon after the jetting was completed.

Study in Missouri

Water jetting has so generally proven satisfactory that the Missouri State Highway Department is now using this method extensively. The state highway department during this last summer made a very careful study of one project in order to secure complete and accurate data regarding settlement of fills that have been jetted, and to ascertain the best methods of jetting. To assist us in making this study, concrete posts were set into the ground to a depth of 3½ ft. at right-angles to the centerline, and about 5 ft. outside of the limits of the sideslopes. A ½-in. rod in the center of the concrete post provided means for accurately aligning all measurements and distances, and also served as bench-marks. These markers are permanent and were set deep enough so as not to be affected by frost and they can be used at any time to determine the settlement in the fill or the pavement on the fill. Cross-sections were accurately taken as soon as the fills were completed, and also after rains, before jetting was started. After the fills were jetted, notes were taken each day for a week, and then once a week until the pavement was poured.

Jetting Equipment

The jetting equipment used was an inch pipe with the nozzle end drawn down to a ½-in. hole. The top was fitted with a T-valve, which kept the supply hose from kinking and also provided a means of spraying the road surface without delaying the jetting. Water was pumped as far as 4 miles through a 2-in. pipe with about 160 lbs. pressure at the pump, or 60 to 80 lbs. at the nozzle.

Settlement

Very little effects were noted from rain which fell prior to the jetting, although there occurred three light rains, and one heavy rain during which 7.18 in of water fell in 40 hours. The jetting was done on 5-ft. centers, the holes being first spudded about 3 ft. deep with a heavy crowbar. The average time to jet a hole in an 8-ft. clay fill was about 45 minutes.

After platting the cross-sections taken during a period of three weeks, the department found that very little settlement occurred later than 48 hours after jetting. Several of the fills which showed heavy settlements were checked for sideslope bulging. The settlement was found to be uniform from the shoulder to the toe of the slope; no bulging effect showed in any case. Data were kept and compared for every fill on 7 miles of work with fills varying from 1 ft. to 14 ft. in height. Most of the fills on this job contained rock, sand, and clay; a test on the average sample showing 28 per cent rock, 21 per cent sand, and 51 per cent clay, by weight. The data secured showed 10 per cent settlement for every foot of fill over 4 ft. This percentage was also found on hard clay fills. The mealy clays and softer soils showed about 15 per cent shrinkage for fills over 4 ft. At the ends of bridges, culverts, and over deep holes where end dumping was necessary, the shrinkage was as high as 25 per cent, but usually about 20 per cent.

We also experimented by surface ponding the fills with water and digging holes at about the same spacing as was done with the jet. The pressure jetting seemed to be more satisfactory. Our cost figures on this work showed 4½ cents per cubic yard as the cost of the jetting, with labor at 50 cents per hour, gasoline and oil for the pump at $4 a day, and miscellaneous items at $1.40 a day. This amount does not include the cost or depreciation of the outfit used.

THE CONTRACTOR'S ENGINEER

By W. M. Willmore, Secretary-Treasurer, Wabash Construction Co., Vincennes, Ind.

(Paper read at 1927 meeting American Road Builders' Association.)

This is a subject that seems to admit of considerable, as well as a sharply divided range of opinion.

As a result of thorough inquiry among a number of good contractors I find them divided into two primary groups. Those who feel the engineer a valuable

asset to the contractors' organization and those who take the opposite view.

These two classes I find are further divided! The contractors who are themselves engineers, I find on both sides of the question; and likewise contractors, who like myself, have had no training in that line, also differ in about the same manner.

Favors Engineers in Contracting Organization

My decision in favor of the engineer in the organization was the result of finding myself, on different occasions, confronted with a question or proposition concerning which I could not satisfy myself as to the proper solution or procedure and for assistance in determining these matters I had the help of good superintendents who, though more practical than I in the construction work, had no more knowledge of engineering propositions than myself.

From personal observation and experience, however, and also from careful inquiry among many of the best contractors in my line I find the class of contractors favorable to the use of the engineer seem to agree that: Unless you make use of an engineer who has also had practical experience as a contractor or who has had experience in a contractor's organization other than engineering duties exclusively the contractor is not likely to find such engineer much of an asset to his organization.

Co-operation

We all desire the co-operation of the engineering personnel of the political subdivision under whose jurisdiction the contractor is doing his work and more particularly the project and resident engineers on state work. The engineer in the contractor's organization can well be the means to that end, if he be competent and tactful.

Not infrequently the project engineer is pressed for time in looking after the many engineering details on his project and if a spirit of co-operation has been cultivated by the contractor's engineer, he can be of considerable assistance to the project engineer, thereby enhancing somewhat the position of the contractor and in nowise impairing the efficiency of the engineer, or engineers on the job. A check up on stakes and other engineering details, by the contractor's engineer avoids errors, and not infrequently, unnecessary work, and through the proper co-operation his assistance to the engineer in charge will very often aid the contractor in the prompt prosecution of his work by seeing to it that all engineering details are considerably ahead of the operations on the job.

Contractor's Engineer Can Be of Great Assistance

Contingent upon the extent of competency of the contractor's engineer, he can be of material help to the superintendent of construction and can more particularly co-ordinate, or at least study the co-ordination of the operations on the job in the interest of greater efficiency in the organization as a whole.

We all know if our construction problems could be talked over with the chief engineer or general superintendent of construction of the various highway departments our troubles would generally be easily handled or corrected, but this cannot be done at all times, and seldom ever on the job, consequently, he must be represented on the job by a "resident engineer," a "project or district engineer" or an "inspector," as the case may be, and from two to three times removed (in the matter of authority) from the chief engineer or general superintendent.

Inexperienced Highway Engineers

Experience has shown that the class of engineers furnished on the job, as a general matter, are young, inexperienced and lacking much or most of the practical side of their profession and consequently, as a matter of course, are all the more given to the one side of their work in which they have had experience, namely, the "theoretical" or "technical" and many times the impractical.

This condition comes as a result that most of this class of engineers are either fresh or not more than a year or so from college, and while nothing in the preceding paragraph or in this paper is meant to convey the least reflection on the young or new engineer fresh from school, rather it is intended to show that a diploma from college, instead of completing their schooling means they are now well equipped to begin that schooling furnished only in one university of the world, The School of Experience, and as a matter of course we are that school, to them, to a greater or less degree.

We continue largely to be that school, for owing to the fact that government and state appointments as a class, pay very modest salaries, they do not attract to their organizations men of mature years and experience to a very large degree, consequently, a few years of ex-

perience with the road builders for this young engineer and he graduates from our school and is off to better and more attractive pay in other lines, hence, as above stated, we continue largely to be that "School of Experience" for more to follow.

I find this statement well supported in several replies received from contractors of whom I have made inquiry for suggestions on the subject matter of this paper. Quite a few, in relating their experience with an engineer in their organizations, have made mention of the fact that the engineer or engineers alluded to were formerly in the employ of state highway departments.

Competent Engineer Valuable Asset

Then again if it is not the case of the young, inexperienced engineer, as just described, it may be an engineer of years of experience in addition to the necessary technical training but must be satisfied with the small salary usually paid in such cases. And what does that generally mean? Either that he is of only ordinary ability, not altogether competent, or may be a failure altogether for anything in his line that offers better pay than state road and bridge work, and this condition cannot inspire the confidence and satisfaction with the contractor he would be expected to have in that particular part of his work.

An engineer in the contractors organization, of the sort mentioned in the first part of this paper, one who has had sufficient technical training to be classed an engineer, and also with sufficient practical experience to be able to tell when the technical should leave off and the practical begin, and with ability to direct others in that branch of the work, is in my opinion a valuable asset to the contractor's organization.

By tying in, as it were, with the young, inexperienced engineer heretofore mentioned, he can soon convince the young man that he is there to work with and not against him. This will inspire confidence and respect and naturally avoid what would otherwise often be bad mistakes and costly misunderstandings.

Contact with State Highway Engineers

Your own engineer on the job is the only man to check the work of the state engineer and likewise the one best calculated to call to his attention errors or mistakes and work out with him a mutually satisfactory correction or necessary change of plans.

How often has it happened with you, a mistake in rough grade stakes, not discovered until the fine grade gang came upon it and as a result your paver lost a day, or a good part of a day, while the error was being corrected? Your own engineer, by checking the engineer in charge, could have caused this correction to have been made far in advance of the paver and have prevented this costly loss of time. A few experiences of this kind during the construction season will cost you more than the time of your own engineer.

Often the paving contractor takes a job where the dirt work is heavy to the point it is advisable or even necessary to sublet the earth work. This is generally done with the proviso that rough grade must be within 2/10 ft. of finished grade. What can be more necessary or mutually satisfactory to you and the grade contractor than your own engineer on the job to see that this provision of your grade contract is complied with?

The services of the contractor's engineer can be made invaluable in the final cross-sectioning of the road, and in the payment of final estimates.

The state engineer on the job is alone as it were. He has problems to work out that to him are just as serious as any of your own. Unless he is a very peculiar individual indeed, he will at times yearn for and welcome the advice, suggestions and assurance that can be furnished by your engineer.

Will not this be conducive to better feeling and understanding than might sometimes otherwise exist, and will not this condition on the job result in that co-operation and co-ordination so necessary to good results?

THE FARMER AND FEDERAL AID HIGHWAYS

By Edward L. Brown, Bureau of Public Roads, Washington, D. C.

One of the most important things that the farmer obtains from this new system of highways is an increased marketing facility by the haulage of various farm commodities into the cities by motor trucks. Since the advent of improved highways the milk transportation methods have been revolutionized. The motor truck at the present time has become the most important means of transportation of milk into our cities. This has already come about since the improvement of the highways started.

In order to determine the extent of

motor-truck use in the bringing of milk into the various American cities, the Bureau of Public Roads conducted surveys in eight or ten cities, and the investigation covered the cities of Baltimore, Philadelphia, Cincinnati, Detroit, Milwaukee, St. Paul, Minneapolis, Indianapolis, and Chicago.

In all these cities, with the exception of Baltimore, Philadelphia, and Chicago, the motor truck transported over 90 per cent of all the milk hauled. The larger cities do not receive by truck quite as much milk, due to the fact that so much of the trucking radius near by the city is taken up by high priced land, and there is very little milk produced within what we call the trucking radius of the city. In most of these cities the milk was hauled in from within about 40 and 50 miles. It is a comparatively short-haul commodity movement.

Gets Market Outlet

Now, to give you some of the reasons why farmers prefer this new method of transportation. The motor trucks gives a market outlet for milk produced in territories which were formerly too far removed from rail shipping points to be reached by wagon. The truck passes the farmer's gate, thereby furnishing a service which can not be duplicated by the railroads. The farmer can not produce and transport at the same time. The driver of the truck acts as the producer's agent from the farm to the city dealer and performs a marketing as well as a transportation service.

Around some cities the trucks are owned by the city distributor, who goes out through the country and collects up the milk from the farmer's gate.

With respect to the other commodities, the farmer is more apt to have his own truck and from time to time he will bring in his products as they come on the market. Milk, being a 365-day proposition, he would rather have it done for him than have to go in every day himself.

The shipment by truck instead of by railroad reduces the number of handlings from six to only two. Heretofore the farmer had to haul his milk across to the local shipping point, and then it was hauled by railroad to the city, and then the city distributor had to come there to the milk platforms to get it. Now it goes right from his farm into the city distributor's place. There is an estimated saving of 5 cents per hundred-weight effected on all milk, trucked in, by the elimination of the haul from the railroad milk platform to the city dealer.

Certain economies have been brought about by this new method, and in that way it has probably helped keep the price of milk down.

While conducting the survey in Baltimore we found that certain truck rates were out of line with other truck rates in the same zone, and upon investigating these we found that where the truck rate was higher it was due to poor unimproved roads. We followed it up a little closer and we found that for 5 miles along an unimproved highway the farmers, on a load of milk were paying an average of $5.00 a day additional that the farmers in just one little community were penalized due to the poor condition of the highway. In other words, the farmers could have afforded to have made an actual outlay on road improvements to the extent of $3,600 a mile if no other truck was benefitted at all besides the one truck of milk.

Transportation Price Cut

In another case, in Chicago, we found where the hard roads reduced the price of transportation to the farmer, and the farmer pays the transportation, so that any saving effected in transportation he would get the benefit of. Now in this particular case we found out where, from Garden Prairie, Ill., to Chicago, a distance of 66 miles over concrete highways, the haulage charge was 35 cents a hundredweight. In the very same territory, over poor roads, for distance of from 3 to 12 miles over dirt roads the haulage charge was from 20 to 25 cents.

Then there was a case of a large Chicago dairy that had a receiving station along a rail line, and this rail line had to be abandoned. They thought for a while that they would have to lose this valuable plant, and they had about $150,000 tied up in this plant. Just about that time Rand Road, that runs out in a northwesterly direction from Chicago, was completed, and they put on trucks, two large tank trucks, on that route, and saved the abandonment of this plant, and the community retained a profitable place to market its milk. That was one instance of the value of the hard roads to both the producer and the city distributor.

There are many highly productive dairy districts in communities which have inadequate rail service. There will be a productive district but they have no means of transportation, and the

truck, after the building of the highway, has been able to get in and collect daily the milk and farm products and haul them to the nearby cities.

The rates compared to railroads are practically the same, only the farmer is saved a certain amount of time each day. He does not have to go to the station to ship his milk. The milk is collected right in front of his door and the rates are nearly the same for equal distances. The saving is merely one of time to the farmer, and not a saving in the particular rates.

That might mean as much to the small producer, or more, than the actual freight charges, the time of going from his home to deliver to the station each day. His man or the farmer himself might spend the greater portion of the morning hauling the milk over to the loading point.

It develops dairy sections and it helps the small farmer as well as the large farmer. I have figures showing how it not only affects a saving to the farmer but the consumer gets a better price.

Something new has come up recently in connection with the value of the hard-surfaced road to the farmer, and that is the farmer can market his products directly to the passing motorists. This new value lies in his being able to sell his products right at the point of production.

The development of roadside markets closely parallels the construction of hard-surfaced roads. The use of the automobile brought the city consumer into the country in ever-increasing numbers and greatly enlarged the number of possible buyers which pass the farmer's gate.

The farmer has found that to make a success of roadside marketing a person must first possess a desirable location along a heavily traveled and well maintained highway.

Roadside Markets

Certainly it would be interesting to some of you to know how profitable some of these roadside markets are. There are roadside markets where farmers sell as high as $50,000 worth of produce right at the roadside. Of course, that is a very unusual case, but there are numerous markets in Maryland that sell over $10,000 worth of produce a year.

One of the principal reasons for the establishment of these markets along the highway is that it eliminates all transportation charges in so far as the farmer is concerned. In Maryland we surveyed 100 of these markets and found that 69 out of 100 were successful in eliminating all local hauling. They sold their produce right at the point of production.

The things they sell are dairy products, vegetables, berries, etc.

In Maryland last summer 100 of these roadside stands surveyed sold $267,000 worth of produce direct to the motorists, and this thing just started in the last two or three years. In New Jersey during 1924 we have figures showing that 131 stands sold $305,000 worth of produce direct to the motorists.

Roadside marketing offers a wonderful opportunity to the farmer living on a well-traveled highway. With our whole country fast becoming covered with a network of improved roads, maintained by state patrolling, and automobile traffic increasing every year, the wide-awake farmer will see the possibilities for selling his produce for top prices at his own doorstep.

Roadside markets are an economical asset to any state when they are conducted by the actual producer. You see, it has been so profitable that there have been some cases where hucksters go out there and sell stuff to the motorists over week-ends, something which they could not sell during the week in town and which they would take out and dump on the unsuspecting motorist, and if you ever bought any poor quality stuff it has probably come from one of those men and not from the actual producer.

Eliminates Charges

This method of selling eliminates transportation and distribution charges and enables the grower and consumer both to profit thereby. Moreover, the consumer has the advantage of a supply of fresh products that have not been bruised by passing through the customary channels of distribution. You can see that if various small fruits had to be hauled into town and passed through the wholesaler and retailer, they naturally would not be received in as good condition by the consumer as if he travels over the road and buys them right at the farm, and the farmer gets a better price than he otherwise would and the consumer often can buy them cheaper, too. The price usually is between the wholesale price and the retail price. The farmer sells a little below the retail price, because he realizes that the consumer is furnishing the transportation.

We are making a study of the various commodities transported in order to de-

termine just where the farmer is benefiting by this large appropriation of money, and feel that he is receiving many distinct benefits by the construction of improved highways.

The commodities most usually handled are perishables, perishable commodities. They are vegetables, fruits, poultry, eggs, dairy products, honey, jelly, preserves, and home-canned goods.

DIFFICULT FOUNDATIONS CONSTRUCTED BY SIMPLE METHODS

By Frank W. Skinner, Consulting Engineer, 20 Vesey St., New York, N. Y.

Public buildings, especially very large and costly ones, generally have their location determined regardless of convenience or economy of construction operations. Great difficulty, delay, danger and expense is sometimes due to the presence of rock, quicksand, water, etc., underground, and to the presence of important structures very near them or of heavy traffic and limited working space. The manner in which some of these difficulties were overcome in the heart of New York, affords suggestions that may be valuable for municipal work in many other towns and cities.

Where neither wood nor concrete piles or spread footings were permissible, the concrete foundations for a costly bank and office building covering an entire city block on Broadway between 73rd and 74th streets, New York, were safely and quickly constructed in open pits that, by virtue of ordinary methods, standard equipment and extraordinary care were successfully sunk through wet, treacherous soil containing many obstructions. The work was done without obstructing the traffic or endangering the public, althought the site was between two congested thoroughfares that necessitated that all operations be conducted and materials stored within the limits of the lot.

Excepting for the steam shovels that handled about 20,000 yds. of spoil in the general excavation 20 ft. deep and the electrical-driven 2-drum Lidgerwood hoisting engines and swingers that operated 72-ft. derrick booms commanding the entire area, all of the mechanical equipment was operated by compressed air at about 100 lbs. pressure furnished by two National Brake & Electric Company's compressors installed with their receiver and the contractors' office and small sheds along the Broadway curb where sufficient space was available without interferring with traffic.

Light double-acting steam hammers, operated by compressed air, and handled by the derrick booms, drove the wooden sheeting around the sides of the main excavation as well as a considerable quantity of 15 to 25-ft. Lackawanna steel piles for the foundation pits, most of them about 5 or 6 ft. square.

The bottom of the main excavation was about at the original water level which was lowered about 8 ft. by a steady pumping in one of the foundation pits, used as a sump, that was carried down about 50 feet below street level, including 12 ft. through the soft, decomposed rock.

The earth was excavated by hand, and a considerable portion of rock, varying from 2 to 18 ft. in thickness, which was soft, decomposed or cracked, was excavated with the aid of pneumatic pavement busters and jackhammer drills, the latter boring vertical holes about 4 ins. apart around the entire circumference of each foundation pit and about four inclined lifting holes in the middle of it, all of which were charged with small quantities of 40% dynamite, covered with wire rope mats, and fired without danger or inconvenience to the public or the workman.

Notwithstanding the drainage through the main sump, large quantities of water collected in the pits and was removed by a battery of six pumps operated by electricity and moved from place to place as the work required.

A street level working platform was extended over part of the general excavation to serve for loading and unloading trucks and for temporary storage. On it were installed two concrete mixers adjacent to which small quantities of sand, gravel and portland cement, furnished daily by motor trucks, were stored, and where there was mixed about 2500 yds. of 1-2-4 concrete, most of which was spouted directly to position in the piers, concrete floor and lower part of the retaining wall, through wooden chutes supported on shores and trestles and provided with branches and gates diverting the flow to any required position.

Another mixer was also installed at street level and furnished concrete for the floor slab and for the upper part of the retaining wall, the latter being chiefly distributed and dumped with wheelbarrows.

Nearly 100 tons of deformed reinforcement bars were used in the floor which was designed as a continuous slab supported on the concrete piers about 50 ft. apart and for the retaining wall, 22 ft. high that was built with a horizontal tongue and groove construction joint midway between the top and bottom.

The sides of the wooden wall forms were spaced and held together by Richmond Tyscrus 2 or 3 ft. apart, that were made with specially fabricated steel wire tires having at each end a standard ½-in. lag screw that provided for accurate adjustment and was easily withdrawn for re-use when the forms were stripped. Concical washers removed with the lag screws left suitable openings in the concrete to provide for pointing with cement mortar that sealed the permanent ties left in the walls.

Where the excavation extended beyond the building line on the east side of the lot, the sidewalk was carried on a heavy wooden platform with longitudinal stringers that overlapped several feet on the crossbeams that supported them, thus enabling the latter to be shifted to give clearance for construction below.

Very careful supervision given to the sinking of the pits and especially to the removal of obstructions under their sheet piles, supplemented by the thorough draining of the general excavation, and the special pumping in the pits enabled the difficult work to be done safely notwithstanding the unstable character of the ground and the lack of working space in the small pits, many of which were excavated simultaneously so that by the employment of a force of about 100 men the excavation and substructure work were completed in about four months.

The main feature of the building, which was designed by York & Sawyer, architects, is the wide and lofty banking room flanked on both sides by mezzanine floors for bank purposes and spanned by long roof trusses from which are suspended its ceiling and three rentable office floors. Spencer White and Prentis is the contractor for the above described substructure work.

REDUCING INFILTRATION INTO SANITARY SEWERS

By D. C. Newman Collins, Township Engineer, Cranford, N. J.

(Paper read at 1927 Meeting of New Jersey Sewage Works Association.)

The infiltration of ground water into sanitary sewers is manifest to many municipalities and the remedy is elusive. Our sewers rarely give trouble in dry, warm weather when water consumption is greatest and yet they overflow during wet periods with no compensating increase due to domestic use. Overflowing manholes testify to an overreaching of capacity but defeats analysis of definite source of the trouble. To rebuild a sewer system is a task of too great consequence to be considered and where long trunk lines exist, combination storm and sanitary sewers are very expensive. Cranford has about four miles of trunk line of tide water and my judgment prompted a persistent campaign against infiltration and obstruction in the sewers.

Results of Campaign

In 1919, our population of 6,000 suffered most intolerable conditions of backing up house sewers and overflowing manholes for periods of 10 or 12 days in average wet periods. Our outfall sewer having a capacity of 3,000,000 gal. per day, this maximum flow might be taken at 500 gal. per capita, for 10 days or 5,000 gal. per capita. Today, after the addition of many miles of new sewer and a population estimated at 10,000, we have very little complaint, our manholes overflow only in a few places for a few hours at exceptional times, so that our per capita flow may well be assumed at 300 gal. per day. Our work is going on.

Roof Leaders and Y Branch Ends

The practice in Cranford is to exclude roof leaders from discharging into the sewer, but we permit cellar drains from the cellar floor. Just what actual conditions exist we do not know, but we have a suspicion that many roof leaders and perhaps property drains find their way into the sewers. Very likely the ends of Y branches contribute a serious leakage in the aggregate and poorly constructed or loosely bedded house connections contribute materially to the trouble. While we have some leaky manholes, I do not think they alone cause serious trouble.

Cranford lies in the Rahway Valley with the Rahway River winding through town in a north and south direction. The tributaries which feed storm water into the river find their way mostly through private property, which refuses the responsibility of keeping them open, with the result that storm water is retained, saturating the soil and causing general abnormal conditions.

Private Line Poorly Laid

The first actual work done was in

1921 when we started a gang of men with an improvised outfit of buckets and ropes at theoutlet below Rahway and we made successful progress for about a mile when we found one section completely filled with quicksand deposited from a long private sewer which had been poorly laid and supplied an unlimited flow of quicksand as fast as we removed it. We took up the matter with the owners of the private line and, as we had spent our allowance, we let the owners have our men to reconstruct and clean this lateral.

Cleaning vs. Flushing

We then purchased two complete sewer cleaning outfits, consisting of special buckets of different sizes, wire rope and hand winches. We put three men on each outfit, who, working together, could assist each other in emergency, and we cleaned completely our entire four miles of trunk line and each principal lateral in town. The total cost, including equipment, was about $3,500. We did no flushing because I believe this simply pushes obstructions along that should be removed. We preserved photographic exhibits of the material removed, consisting of piles of cobbles, road stone, roots, sand, ashes and miscellaneous materials, most of the accumulation being just down stream from right angle bends.

One specimen consisted of a solid mass of roots that weighed 60 lbs. and looked like a lump of crude rubber, being masses solid with mud. It measured about 8 ins. thick and in form of an L of about 18 ins. on each angle. It was taken from a 20-in. line about 25 ft. deep and had probably alone caused a big percentage of our trouble. Without going into a detailed description I might say that many piles of material from a single length between manholes would fill a small truck.

Systematic Use of Street Gang

This helped immensely and we now put on our men every fall after our road work and cleaning for the winter is finished and keep them on sewers until all laterals and other troublesome spots are clean. We usually put $2,000 in our yearly budget for this work, but rarely spend more than $800 to $1,200. The work is all done slowly by hand power, working in the direction of the flow and we find that a slowly moving bucket will increase the pressure of the flow and push ahead into the manhole much more sediment than the bucket will hold. High speed work we found will create a suction that holds back the sludge and advances the bucket ahead of the flow, beside inviting damage to the sewer and equipment.

Lowering Ground Water Level

From time to time we worked persistently on our drainage to lower the ground water level. At first we were only able to open drainage brooks and with the aid of the Union County Mosquito Commission did much work in relieving spots where storm waters collected. We began a campaign to secure right-of-way for storm sewers and have built some of them with most surprising results. During our day to day work we have searched for bad leaks. We found in one case an 8-in. private sewer which crossed an open brook and a broken section would feed its full capacity into our sewers in wet periods. We found an antique manhole outfit where an 8-in. pipe had been installed in the river, presumably to flush out a siphon underpassing the river. This 8-in. pipe was entirely open and the gate valve regulating the flow from the river was rusted out. We lowered the river and plugged the pipe permanently.

We found a new development of houses in a section where storm water was held up, each one of which had the usual 4-in. sewer cleanout in the cellar floor. In the spring, storm water collected in this vicinity for want of outlet and of course these cleanouts were all opened and each one might contribute 150,000 gallons per day into our sewer system. We immediately built a storm sewer so that the cleanouts need to do no more overtime work.

A more recent case was a new development where 6 houses were built and 5 cellars dug immediately across a well defined drainage brook in a valley, in spite of our request that they drain the property before occupancy. When later they asked for a sewer for these houses we refused to construct it until they delivered to us complete right of way for a storm sewer to drain the land. These houses all had cellars full of water and their sewer cleanouts were waiting for the sanitary sewer to drain the surface water. This storm sewer is now being built.

Another important improvement was made to one of our river dams. The dam was originally built with a private boat landing on one side. We bought the land for park purposes, demolished the boat landing and rebuilt the dam with nearly 10 ft. more spillway. Before this was

done the banks at this spot were washed away at least one a year and since we remodeled the dam no trouble has been encountered and the high water line is much lower. We are steadily on the lookout for drainage obstructions and leaks. We are pushing storm sewers as quickly as possible and believe every effort is well spent.

Menace of Uncharted Sewers

A very recent discovery showed three houses connected to an old sewer which we knew nothing about. On digging it up we found it flowing nearly full of surface water in a steady flow. We could not trace its source or discharge but expect to rebuild it, cut off the two ends and connect it up properly with manholes.

I do not believe that roof leaders and cellar drains form as serious an overload as is generally believed. If cellar drains are located in very wet spots where surface water collects in great quantities, a suitable storm sewer to dispose of the surface waters will help the situation without necessarily depriving the house owners of means of drying their cellars. We have houses in Cranford where a cellar drain into the sanitary sewer is essential to occupancy of the house and our results show that the prompt removal of the ground water in the neighborhood enables us to avoid cutting out such necessary drains. I can not predict what our total flow per capita will be as we continue the work.

We have found that the annual cleaning at certain places is essential and that a thorough cleaning of a sewer after a street is improved by pavement is very necessary. This is due to the deposit of various materials into the sewer during construction and to the entrance of sand, etc., in making private house connections to vacant lots in advance of improvement.

There are, no doubt, many serious leaks still to be found and many storm sewers still to be built so that while our maximum per capita flow seems large, we have at least removed an intolerable situation at very small expense and hope to reduce it to a much lower unit with great economy.

We are now working on a new and big Joint Trunk Sewer to take in all municipalities in the Rahway Valley. This sewer is an essential enterprise for the future and we feel that our persistent work has relieved us of a menace to health and comfort temporarily, and will reduce the expense in Joint Trunk Sewer maintenance and cost by keeping the needed allotment of space to a minimum.

I can not lose this opportunity to emphasize that this work could only result from continuous and unbroken interest in an important subject that is too frequently either disregarded or misunderstood. Under a changing administration usual to public work many valuable properties are condemned that could be made more useful and there is a great benefit to any municipality if such matters can be put in the hands of some one who takes interest enough to understand the problem and who has tenure of office long enough to produce results.

COUNTY HIGHWAY OFFICIALS ORGANIZE

The American Road Builders Association has just completed the organization of a national County Highway Officials Association, a body of local road officials representing each of the 3,070 counties in the United States. The new organization will function similarly to the American Association of State Highway Officials, and will be known as a division of the American Road Builders'. At its annual convention and road show, the County Highway Officials will have the advantage of the annual sessions of its parent organization.

The organization meeting was held at Washington on June 17, 1927, at which time a constitution was adopted and officials elected. Thomas J. Wasser, supervising engineer of the Board of Chosen Freeholders, Jersey City, N. J., was elected first president. Four regional vice-presidents were elected. They are: Charles E. Grubb, Wilmington, County engineer of Newcastle County, Del.; Edward W. Hines, Detroit, road commissioner of Wayne County, Mich.; John Kirkpatrick, county judge, Wayne County (Benton), Kansas; and Stanley Abel, county supervisor, Taft, Cal.

The constitution adopted resembles somewhat the code used by the American Association of State Highway Officials, and sets forth the purposes of the new association as those of standardization of county road building, maintenance and finance methods, dissemination and exchange of road information, and the stimulation of local road construction.

The need for a national organization of the sort just completed by the Amer-

ican Road Builders' Association through its business director, Charles M. Upham, has long been paramount in the United States. With 3,070 separate political sub-divisions constructing and maintaining highways without technical intercourse or standardization of methods, the waste of county or township funds has been inevitable. The expenditures under local agencies are approximately the same as those supervised by well organized state departments. The roads affected are in most cases thoroughfares of a peculiar nature, being all-important to the immediate district in which they were laid, but at the same time not handling sufficient traffic to justify the construction of the more expensive modern highway. This peculiarity makes the county problem of intricate importance, and emphasizes the necessity for ing, surfacing or otherwise improving technical standards of grading, gravelthe local road. Through such an organization as Mr. Upham has brought into being, a great deal can be accomplished, both from the standpoints of efficiency and economy.

The new association will start its good work immediately. Contact men will be appointed in each county of the United States and report to various committees that will be formed by the present group of officials. The first reports will be delivered on County Officials Day at the Annual Convention and Road Show of the American Road Builders' Association. The latter meeting will be held at Cleveland during the week of Jan. 9, 1928.

The committees to be appointed are those on Survey and Plans, Road Type Selection, Design, Contracts and Specifications, County Highway Construction, County Highway Maintenance, Bridges and Culverts, Materials and Tests, County Highway Legislation, County Administration, Standardization of Accounts, Construction and Maintenance, Equipment, Publications, County Highway Finance, Traffic, Publicity and Special Committees.

In addition to the president, and regional vice-presidents, a board of directors was elected. The members are:

Elected for one year: Charles W. Deterding, county engineer, Sacramento County, Sacramenta Cal.; Jerry B. Zmunt, county commissioner, Cuyahoga County, Cleveland, Ohio; J. T. Bullen, parish engineer, Caddo Parish, Shreveport, La.; Merl Breese, county engineer, Luzerne County, Wilkes-Barre, Pa.; R. B. Preston, county engineer, Norfolk County, Portsmouth, Va.; and J. A. Bromley, county road engineer, Anne Arundel County, Annapolis, Md.

Elected for two years: J. L. Jones, Los Angeles County, Los Angeles, Cal; B. W. Davis, county engineer, Nash County, Nashville, N. C.; Otto Hess, county commissioner, Harris County, Houston, Tex; S. A. Green, roads engineer, Baltimore County, Townson, Md.; R. C. Hill, county engineer, Sussex County, Georgetown, Del.; T. D. Pendegrass, superintendent of roads, Durham, N. C.; and T. H. Baldwin, county engineer, Laramie County, Cheyenne, Wyo.

Elected for three years: H. B. Keasby, county engineer, Salem County, N. J.; E. A. Griffith, chief engineer of roads, Allegheny County, Pittsburgh, Pa.; Charles A. Brown, chief engineer, Orange County, Orlando, Fla.; C. F. Winkler, probate judge, Greenville, Ala.; Thos. H. Maddon, county commissioner, Trumbull County, Warren, Ohio; George A. Quinlan, county superintendent of highways, Cook County, Chicago, Ill.; and E. C. Gwillim, county surveyor, Sheridan County, Sheridan, Wyo.

PENSION SYSTEMS FOR MUNICIPALITIES

By H. Ivor Thomas, City Auditor, Santa Monica, Calif.

(Address at 1926 Meeting of California League of Municipalities.)

Pension systems have been tried and used from the very early days. We hear of them first in the Roman Era but we do not know how they were run or organized. Coming down a little later there are some pension systems in Europe which have been in existence for over one hundred years. However, these have not proven satisfactory, as is shown by the fact that in some of the largest cities in Europe the pension fund has run up to from thirty-one to forty-two per cent. of the payrolls of those municipalities. This could have been avoided if the right principles had been adopted in the first place.

It is the inclination to start a pension system on guess work, and as the funds derived from contributions grow and it looks as if the fund were going to be able to take care of all future liabilities the tendency is to increase the pensions. This leads to disaster. The pension fund plans in a number of cities and states

have had to be re-organized. That means that the people have found out that the amounts they have been saving for the pensions when due have been so far short of the required sum, that in order to meet the payments it has meant such an increase in tax that it is prohibitive. The only safe way to provide for a pension system is to determine first of all, what you intend to create and under what conditions. Then it is necessary to take the history of the employees of the municipality for which the system is to be adopted, for at least five or ten years previous to the time of starting the plan, ascertaining the ages at which the employees of the department were employed and the probable number of employees who will qualify to receive a pension. These statistics should be gone over carefully to find out the true cost of the benefits to be provided.

Although some cities may have no definite pension system, to some extent they set out to meet this obligation, because every governmental authority does actually pension its employees in one form or another. You will find that in a city which has no rules for the retirement of its employees, and no means of keeping them in active service, they will be permanently carried as "dead heads" on the payroll. Instead of being discharged when they are unable to render full service, and when the weakness of old age has impaired their usefulness, they will be retained to perform what work they can. This is not good on account of the criticism it calls up in the minds of the taxpayers. One of the main objections is that all employees retained on the payroll should be able to give efficient service.

There are three plans of pensions usually followed, called the contributory, non-contributory and partial contributory. In the non-contributory plan the municipality provides all the expenses, in the contributory plan the employees provide all the premiums and in the partial contributory they share the expenses. Of these three plans the third has proven the most satisfactory, because the employees contribute their share of the expenses and the kind of benefits that should be provided will enter into the question. First of all an annuity allowance, or retirement allowance is usually made for the pensioner at his option when the employee is sixty or sixty-five years of age and is made compulsory when he reaches seventy or thereabouts. In New York the rates contributed by the employees are based on 1/140th of the average retirement salary which the employee will be drawing at the time of retirement, and the state contributes the same amount. The amount of the pension will be 1/70th of the final average salary received, multiplied by the years of actual service. The average salary is usually arrived at from the last five years of service.

The estimates usually also provide for a death benefit or insurance, and in some cases this is contributed partly by the employees.

There is a very serious matter to be taken into consideration by a municipality starting a new system, and that is to provide means to meet pensions of those already in the service and who will be qualified for pensions before they have paid their share toward any retirement allowance. This obligation has been met by the city entirely.

I am trying to bring out a few points that are serious questions in the case of the City of Santa Monica. A little over a year ago Santa Monica passed a charter amendment which provided that the commissioners should adopt an ordinance to establish a Relief and Pension Fund. It stated that the police and fire departments must come under that plan, and the employees of any other department might be included, and provided further that the ordinance should state what benefits were to be conferred and the terms of service that would be required. Another of the terms was that the city should provide annually an amount not in excess of 1% of the general tax levy towards the pension fund.

Many of the employees in Santa Monica have served the city over ten years, a good many over fifteen and some over twenty. The charter amendment has a requirement that they shall not receive pensions until they have served twenty years. It is provided in most systems now in use that the city provide the expenses of those employees who have already been in the service for a greater or less length of time prior to the installation of the system, up to that date. However, in the City of Santa Monica, this represents a very difficult point, because of the limit to the amount of contributions, in the charter amendment which authorizes its establishment.

The plan in New York bases the rate of contribution on the age of the employee at the time of entering the service. An employee entering the service at the age of twenty, if a laborer will pay a little less than 3½%. In Baltimore for the same age he pays just a little over 3½% and the rate varies from 3½% to over 7% in the case of those entering the service at the age of 59 or over. The rate contributed at the time of entering the service is not changed during the whole length of the service of the employee, except in those cases where arrangement is made for a readjustment of rates according to actual expenses when computed under later actuarial investigations.

In New York the comptroller of the state has charge of the pension fund and there is a pension board which contains representatives of the state and of the employees and in that way works for harmony where any question arises, because the employees are represented on the board. That is a very wise provision to make because you will get the cooperation of your employees to aid you in carrying out the policies.

I would like to repeat the great danger of changing the amount of benefits because you think your fund is growing very fast, so that the ordinary person will think that it will be easy to increase the pension allowances, because the amount of the fund looks very imposing. A pension fund should grow, and must establish a reserve so that it can take care of its pensions when they become due; and the spectacular period of its growth is during its early years, while the reserve is being provided, and before many pensions have become due.

AVIATION IN AMERICA

By Wm. P. McCracken, Jr., Asst. Secretary of Commerce for Aeronautics, Washington, D. C.

(Presented before Western Society of Engineers March 15, 1927.)

We like to think that we are always alert, up to date, progressive, and have very modern ways and methods of doing things, and yet there is a story which I think somewhat illustrates the attitude of mind of the public in general at least towards the subject of aviation.

It has to do with a former resident of this city who is very much respected and revered, and he happened to come from that country where Presbyterianism thrives—Scotland. He engaged in the banking business in Chicago, and after he acquired some of the wealth that was obtainable here, he went back for a visit to his native heath. On his return, one of his neighbors inquired of him what it was that impressed him the most about his visit. He said, "Well, you know, I have always rather resented the stories they tell about the Scotch being so penurious, but when I got back there I discovered that there was really some foundation for it. Why, they actually carry it into their business. Just take, for example, I went into a tobacco shop in Glasgow, and I bought a cigar. I looked around and there were no matches or lighters on the counter. I said to the clerk, 'May I have a match?'

"He offered me a little paper of matches and said, 'Ha' penny.'

"I said, 'But, my good fellow, I don't want to buy a match. I came in here and patronized your shop and bought a cigar. Do you mean to tell me you won't give me a match to light it?'

"The clerk said, 'Ha' penny.'

"Then I went on and explained to him that here, over in the States, you could go into any drug store or place where they sold cigars and most of them had lights on the counter, burning. If not, they had the packets of matches free, and you could take them whether you patronized the shop or not. Certainly it ought to be when a customer bought a cigar that he would not have also to buy a match. That didn't impress the clerk at all. He just held onto the packet of matches and said, 'Ha' penny.' And, do you know, I had to walk all the way back to my hotel to get a light." (Laughter.) That is somewhat illustrative of the way I think a good many of our American business men are on the subject of aviation. They think that it is a fine thing, that it is a coming thing, but they never think to use it when it comes to sending their mail. They put the old two cent stamp on instead of the new ten cent stamp, and don't take the time and trouble to find out about the extra service that they could get for an additional eight cents. In fact, very often they will carry it to the extreme of putting on twelve cents, namely a ten cent special delivery stamp and the two cent stamp, when they would save three to four times as much time if they would put on an air mail stamp, and save the two cents. They save much more time by the speed of the airplane than they

can by the speed of the messenger boy who delivers the special delivery letter.

This afternoon I listened to three very instructive talks on the subject of aviation. I thought that if I were going to discuss aviation in America that it behooved me to go over and listen to those talks myself and find out what, if anything, there was that they did not cover. I found that the package had been pretty well wrapped up and included most of the worth while things on the inside. I shall try to avoid repeating the things that were said this afternoon, although I may take occasion to refer to them, in the course of my remarks.

In the first place, as we all know, aviation had its birth right here in America, yet a good many of our people have developed in connection with it something that is rather unusual in the American frame of mind, namely, what I choose to call, using a borrowed term, an "inferiority complex." Most of them will say, as the chairman did tonight, in the course of our conversation—he did not make it as a statement, he put it in the form of a query, but most of them will say, if you talk to them, "Well, is it not too bad that we are so far behind the rest of the world in aviation, when the airplane was really invented here?"

U. S. Leads the World

The truth of the matter is that the United States today leads the world in every phase of aviation, with the exception of passenger carrying and a few of the sport records. In every other phase of aviation, including carrying air mail, flying at night, carrying goods, the miles flown, the passengers carried for taxi purposes, sport flying, aerial survey, cotton dusting and insect extermination not only on cotton but trees and other things, America is far and away ahead of anything that Europe is doing. We were flying thousands of miles at night when Europe was not flying hundreds of miles, and Europe is not today anywheres near up with us when it comes to night flying. We really have a great deal that we can be proud of, if we only knew what was going on in this country in connection with aviation.

I want to say just briefly, perhaps, a word about military aviation before I go further with the commercial phases of it. We have had a great deal of talk and public discussion about our military and naval aviation since the close of the World war, and the last Congress, which has just adjourned, at its first session, put through the program recommended by the select committee of Congress that investigated the subject, and the President's Aircraft Board, or the Morrow Board, as it was called.

Our military and naval air service are already beginning to show the effect of this new legislation. As you know, it created an Assistant Secretary in the War Department and an Assistant Secretary in the Navy. This legislation contained a five-year building program in order that the two services might be provided with new and modern aircraft. It also contained a great many other beneficial provisions.

Like all constructive measures, it is not going to accomplish everything at once. We must be patient and give the new policies a fair chance to be proven. Furthermore, we must back it up, and see that the five year program is not merely a program on paper, but is made a reality. In order to do that, it is going to mean some appropriations by future Congresses. Congress will only act provided it knows that the people back home really want this thing accomplished, and we can't be lulled to sleep by the fact that this nation is absolutely safe from attack in the air simply because there is no air force that we know of at the present time that is competent to make a major attack upon our shores from their home base. The development in aircraft, both heavier and lighter than air, is such that perhaps before the five years are up, if not then, at least shortly thereafter, it is going to be perfectly possible to build and operate aircraft that will be able to make things very interesting for this country in the case of a real emergency. So we have got to carry on and see that these programs are actually carried out and put into effect. I believe that they will be, but we don't want to get the idea that simply because a resolution has been adopted or a program laid out, the job is done. It is only just started.

Transport Operates on Schedule

Now, when it comes to the commercial side of aviation, there are two distinct classes. One is known as air transport. Those are operations on fixed schedules over regular routes, and they are increasing quite rapidly. At the preesnt time, commercial air transport operations are something better than 20,000 miles a day in this country. That means planes are flying this distance on schedules that are being kept with a regularity comparable

with that of any other means of transportation. It is true they are affected by weather. But every means of transportation is affected by weather. I glanced at the paper this morning, and I think they said something like 4,000 passengers were held outside of New York Harbor for 24 or 48 hours, because of fog conditions. Nobody thought anything about it or was particularly concerned. I suppose those on board were not happy, but they knew there was no way of avoiding it. The one worst element that the aviator has to contend with, is fog.

In the discussion this afternoon, Major Putnam asked the question about the relative advantage of our proposed lake front landing field, and some of those that might be located farther away from the Loop, because of the fact that smoke and fog are apt to congregate on the eastern side of the city and make it difficult to get in and land.

Service Made More Reliable

There are two answers to that objection. The first one is this. Eventually we will whip this fog hazard and the sooner we start developing this field the better off we will be. The second one is that even before the fog hazard is eliminated, the great majority of the time you will be able to land on our lake front field, with a saving that will be well worth all that it costs. There will always be outlying fields, and when fog conditions will not permit a landing on the lake front, planes can use them.

As to what is being done towards whipping this fog problem, there are three methods of attacking it. One is with the lights. That was discussed this afternoon somewhat; the neon light is being experimented with at present. We have some in this country and we expect to have more in the very near future. In addition to lights we are working with electrical apparatus. While the radio beacon at the present time will only guide the pilot on his course, it is hoped that it may be developed so he can tell his exact height above the ground and his exact location with reference to the landing field. When I say exact I don't mean a matter of inches, but I mean exact enough so that he will be able to land by means of those instruments. I am not sure it is going to succeed, but it seems possible.

The third method and the one which seems least likely to succeed, and yet you never can tell how these things are going to work out, is a method of fog dispersion. They have been attacking the problem from overhead, and while they have been able to do it to some degree of success, it has not been very marked, and there is an indication now that some people are going to try to tackle it from the ground up. If they can give the pilot even a fifty-foot ceiling it will be worth while. This would enable him to make a landing if he has a pretty accurate idea of how far he is above the ground. So ultimately I think some method will be worked out by which we have the fog problem licked. We have not got it yet, but it is receiving attention.

Air Lines Cover the Country

Let me sketch briefly our air transport system as it exists today. There is a line that extends the full length of Pacific Coast from Los Angeles to Seattle, and another from San Francisco to New York. A feeder line comes up from Los Angeles to Salt Lake City. There is another line that starts a little way from Seattle, at a point in Washington known as Pasco. Mail is brought over that part of the mountains at night and is flown from Pasco to Salt Lake. On the eastern slope of the Rockies, they are flying from Cheyenne, Wyoming, to Pueblo, Colorado. Out of Chicago we have five lines in operation, one to Detroit, which was the first one to be started, one to the Twin Cities, one down to Dallas, one to St. Louis, and then the transcontinental operation. As Mr. Colyer told you this afternoon, there are to be two new lines opened out of Cleveland in the very near future. The Colonial Air Transport is already operating between Boston and New York and a contract has been awarded for service that will extend from New York to Atlanta. This means that about eighty of the principal cities of the United States within the current year will be getting air mail service, and with this is rapidly going to follow express and passenger service. Some of these lines are already carrying passengers. Others of them expect to go into that phase of it during the summer months when flying conditions are a little better than they are in the winter time. They think there is a better chance of attracting passenger business. As you probably know, the American Railway Express Company has already entered into a contract with one of the large transport operators for hauling express over a distance of about 2,000 miles, and un-

doubtedly other contracts will be made in the comparatively near future. So this thing is growing. I think perhaps one of the best indications of how rapidly it is growing is the fact that during the last six months of last year the air mail receipts increased 75%, according to the information given out by the Post Office Department. I have forgotten whether it was 75% over the similar six months of 1925 or the first six months of 1926, but the two periods are so close together that it does not make very much difference. It is growing very rapidly.

Many Special Services Used

In my opening remarks I said something about air service operation. I wanted to give just a little more of the detail of that work. I think it will be interesting to engineers, particularly. That side of it has to do with aerial survey work. Engineers all over the country have had occasion to take advantage of the photographs made from airplanes. They find that it is advantageous in laying out their projects, particularly power development projects and things of that kind. Even smaller jobs such as locating a factory, are done better when an aerial photograph is available. There is a constantly increasing demand for this particular type of work, and there are a great many concerns in this country that are doing a very substantial business in that field of aviation. These operators also conduct what we call aerial taxi service—sometimes the man does not want to rely on the camera, he wants to go up himself and be flown over the territory, or it may be he wants to get to some particular point in a hurry, and the only way he can get there is by airplane. You find these air service operators ready, willing, and in most cases, able to take you to your destination at a great saving of time over surface means of transportation.

Air Mail Solves Emergencies

Perhaps it would be of interest if I cited one or two instances that rather impressed me of service that the air mail has rendered to the business man. Two of the instances, particularly, should appeal to engineers. There is a town downstate which has a rather large factory with a branch on the Pacific Coast. It happened that they learned of a contract that was to be awarded in Philadelphia on a certain day by competitive bidding. In connection with the bidding they were required to submit certain plans and specifications. The man in their organization who was best fitted to do that work was an engineer located at their plant on the Pacific Coast. They sent out word to him by telegraph what was wanted to be done. He went right to work on it. When he got his plans and specifications together, of course he could not telegraph them back. He sent them by air mail. The air mail carried them from San Francisco to Chicago. They went on the branch line downstate, getting in there in the morning. They set their estimators to work on it and they worked all day and got the plans and specifications and estimates wrapped up just in time to catch the plane out that evening for the east. They came up here to Chicago, made connection with the Chicago-New York overnight and were in Philadelphia the next morning in time for the letting of that contract at noon. What makes it a really good story is that the Peoria firm got the business. It cost them something between $200 and $300 in air mail postage. If they had not had the air mail service and had wanted to employ an air taxi operator for that particular service, I doubt if they could have found one who could do it, but if they had done it, it would have cost them in the neighborhood of $5,000 or $6,000. It might have been that it would have been worth it to them, but you can readily see what an advantage it was to them to be able to get this service for something between $200 and $300. That was the amount of their special charges, in this connection.

Another striking example was a ferry boat that went out of commission on San Francisco Bay one Saturday morning not very long ago. The part that was broken could only be manufactured by a factory located in New England. They used the long distance telephone to get the word to the manufacturer what part they wanted. By working overtime the new part was finished and ready for shipment on Saturday night. It came out as far as Chicago on the overnight. Then it had to lay over here twelve hours, because they don't go right on through on the overnight schedule, but it started out the next morning again for the Pacific Coast, and was there Monday evening late, and was delivered to the people Tuesday morning, and Tuesday afternoon that ferry boat was in commission again on San Francisco Bay. Of course that was worth many times what it cost the owners of that ferry boat to get it

back into commission. It was not only profitable to the owners to use air mail, but it rendered a great service to the commuters, because you can well imagine with one of those large ferry boats out of commission, there were many people inconvenienced getting to and from their offices and their homes.

Must Have Daily Business

Just one other instance. There was a man down here in Indiana who suddenly found that he wanted very quickly an article which could only be procured in Salt Lake City. It was in the afternoon that he wired out to Salt Lake City for this particular article, which I think weighed about a pound. In his wire he said, "Send by the fastest means possible. Rush." I don't know whether he thought it was coming by air mail or not, but it was just 26 hours after he had dictated that telegram to Salt Lake City before that one-pound package was on his desk down here in Indiana. It was not even on the air mail line. Of course, it just happened the rail connection with the air mail line was right—whether it came from Chicago or Bryan I don't happen to know, but some way or other it got down to him in short order, because it was 26 hours from the time he sent the telegram to Salt Lake City until he got his package. That is service every one of you will be mighty glad to take advantage of some day or other, but you can't wait until you have the emergency and expect to have the service waiting for you. You must make use of it in your everyday operations, then when the big emergency comes along you will find it has been money well expended to keep air mail service in operation.

In addition to the commercial operations I believe there is going to be a great future in sport flying. The American people like recreation, the automobiles, the good roads, while they are serving commerce, were largely made possible by people who wanted recreation. They wanted to get further out from the city in order to enjoy their spare hours. When we had our first means of transportation, namely that of walking, people lived in very small communities. They could not get very far away from their place of business. It took them too long. Then the horse and buggy with dirt roads, came along and people moved a little further out because of that type of transportation. Along came the street cars, first horse, then cable, then electric, and the circle gradually enlarged. Finally with the automobile and steam railroads providing suburban transportation, the circle has a radius of about thirty miles. There are some commuters here in Chicago that commute even further than that, but I think you will find most of our suburban population is located within about thirty miles of their places of business.

Extend Suburban Limits

Now, there is no reason why, with the development of airplanes, we can't extend that circle a great deal more. Probably we will be joining forces with Milwaukee on the north, so that controversies will arise as to whether a suburb belongs to us or to them. It will extend likewise on the west, on the south and even across the lake east. The people will be flying in planes operated by public service corporations rather than their own, but a good many of them will be using their own planes simply and solely for the advantages derived by getting further away from the big congested centers of population in which they do their work, but where they don't want to bring up their families.

There is a good deal in the contest side of aviation, not that a great many people will want to fly for speed records of 300 miles an hour and better, but you don't have to go 300 miles an hour to have a good contest with an airplane. They offer an excellent opportunity for sport the same as the sailboat or motor boat. A lot of people get good fun out of motor boats that won't do more than fourteen or fifteen knots, notwithstanding the fact that Gar Wood and his crew race up and down the Hudson with the 20th Century Limited. It is going to be the same way when it comes to airplanes. They will have contests of planes with certain power plants in them or some other restrictions and classes. This is going to appeal to the red-blooded American sportsman and we can look for a big development in that field. All of which means we must have community airports. You can't expect each individual owner to have his own air port, unless we can make some radical changes in the size of space necessary for an airplane to land and take off. While that particular feature is being given consideration, it does not look as though we were going to be able to reduce the size in the immediate future.

The Big Question Is Terminals

We never yet have had an improvement in transportation that has not led to congestion of terminal facilities. Your President tonight was telling me about the trouble that they are having with their railroad terminal problem. Your automobiles have made street widenings necessary at the cost of millions of dollars to the taxpayers. While it may be that development in aviation will result in reducing landing field areas instead of requiring an expansion, if it does it will be contrary to anything that we have experienced in transportation so far. The biggest item of expense in building an air port is the land. You know perfectly well that your land values are not going to decrease, and nothing will take it away. So there is very little to lose. You are still going to need your hangar facilities. You will always need your shops. You can do it better collectively than you can individually, and there is no question but that the larger and more adequately equipped your air ports are, the more you will attract the business and the air traffic to your midst.

Some of the people, however, think, "Well, now, that is all very good, but what about the safety side of the problem?" Well, first of all, let me tell you an incident which perhaps you will think is rather exceptional. I will agree it is, but it is somewhat impressive, nevertheless. There is a chap who comes from the State of Illinois in the Navy Air Service. He flew in the Schneider Cup Race in England at the time the Schneider Cup was brought over to this country. He had flown through the war, in racing meets afterwards, was a test pilot taking all kinds of chances, yet he had come out of it all without a single scratch. He accidentally happened to trip on a rug and fell downstairs and dislocated his neck. That is the oldest means of transportation that any of us know anything about, yet it was the one that proved dangerous for him. Fortunately the doctors have been able to keep him going since then.

Safety is Increasing

But just to show you how safe aviation is getting, the insurance people—you know there is not a harder-headed group in the world than the insurance men when it comes to selling them anything—are actually beginning to write business on the lives of the aviators, and they are coming down with their premiums right along. Large insurance companies have taken off from their accident policies the restrictions as to air travel for those not engaged in aeronautics. Many of the accident policies written by the larger companies carried that restriction, but now that pendulum is swinging the other way and insurance companies are beginning to take away that restriction and are extending their protection to the men actually engaged in the operation of airplanes. They would not be doing that if it was not true that it was getting to be a relatively safe means of transportation.

How about the aircraft industry itself? Well, there never has been any improved means of transportation that has not meant the building up of a big industry. There is going to be a big industry grow up around aviation. It is true that it had a mushroom growth during the war period. Then it flattened out flatter than a pancake, because the army and navy both were oversupplied with material, but a nucleus was kept together. They are gradually expanding, and as the civilian demand for aircraft increases, the industry will prosper. Mr. Van Zandt told you about Columbia, Pennsylvania, this afternoon, in the course of his remarks. Let me tell you about a little town of 5,000 down in Missouri. It is no use to mention the name of it, because I don't think anybody here would know it. After the war there were two young fellows down there who felt there was going to be something in this aviation industry. So they started to work not with the army and navy, but they took army and navy surplus and started to rebuild it and sell it for civilian use. Last year that concern did a business of $500,000. That is pretty good business for a town of that size. Of course, it is not a big industry as we know it here in Chicago, but that shows you relatively what may be expected.

Air Transport Brings Local Business

There is another concern, the President of which was in my office not long ago. He said he thought he did very well last year when he sold fifty planes. That was the output of his factory. But he said—this was at least two or three weeks ago—"I have actual orders on my books that will require our factory to produce one plane a day for every working day in 1927." That shows how it is going.

I was talking tonight before the meet-

ing with a man in the Monadnock Block. He said, "Confound it, what is the matter with the manufacturers in this country? I have been making a survey for a concern interested in opening up an air line. I write around to these manufacturers, and I find that they are all so far behind in their orders that they are not interested in my inquiry as to what it is going to cost. If they reply they quote a price they know perfectly well we can't afford to pay if we are going to get quick delivery on the stuff." That is the condition of the industry today. There are going to be losses. Don't get the idea that aviation is going to be different from anything else; public utilities, banks, retail stores, railroads, have all had a certain percentage of failures. It is going to be true in aviation just as in anything else, but don't think and judge aviation by its failures. On the other hand, remember that there never has been a speedier means of transportation or communication that industry and commerce have not taken advantage of and built up around it a great transportation system or communication system, and with it a great industry, requiring the highest skill of engineering. Therefore it ought to be of particular interest to a group like this.

I realize that this is a Chicago meeting, and I want to say just a word about Chicago's place in the picture. Naturally commerce is going to flow along the usual lines unless it meets with some decided resistance, and as was remarked this afternoon, the fact that these air lines radiate from Chicago is not due to any particular initiative on the part of the Chicago business men in getting that service for this community. Those services were established here because their owners felt that here was the business that they wanted to get.

Supply Industry is Important

On the other hand, there is not any community in the world that can afford to turn its back on an improved means of conducting business. It behooves Chicago to take advantage of this natural opportunity that it has to use these facilities, to provide better facilities for their use, and to take an active and wide-awake interest in developing the aviation industry right here in our own midst. It is good practice for the Chicago business men, both for the business that it will attract here, and because they can conduct their business easier and better and with more profit to themselves.

Why, it was only a few months ago that I was out in Omaha, and I was talking in the city council there about an improvement of the Omaha Municipal Air Port. One of the good city fathers turned to me and said, "But do you think that Omaha would be justified in spending $250,000 to improve that land for an air port?" They already owned the land. I thought for a minute of how I could best explain it to him, and I said that it would pay 10% annually on that investment to the banking interests of Omaha alone due to savings of interest on their clearings.

He said, "Are you sure of that?"

I said, "No, I am not sure, but that is my best estimate and I think it is conservative." Of course, he rather douted it. I don't blame him. But as I was walking down the street from the city hall I was introduced to the President of one of the large banks and I told him of the remark I made. He thought for a minute, and then he said, "Our bank alone would save that on the transactions we have." Later he revised his figures and said perhaps it would not be quite that much. If it means that to a city like Omaha, what does it mean to a great city like Chicago? And we certainly want to do everything that we can to see that the best possible air port facilities are established here, providing an opportunity for the industry to locate and expand. Detroit, Cleveland and Buffalo are fighting hard for it. Buffalo has built a big air port of something over 600 acres, with huge municipal air port buildings built of steel, stone, concrete, and brick, the very latest most modern type of construction, and they have not as yet a single air line that touches Buffalo, but they are going to get air transport service. They have part of the aircraft industry there and they want more of it.

Issues Bonds for Airport

About two weeks ago bids were opened for carrying air mail between New York and Atlanta without a scheduled stop at Baltimore. It happened that I was speaking before the Baltimore Chamber of Commerce on the subject of commercial aviation the very day that the Postmaster General was opening the bids on that route. I called attention to the fact that Baltimore, one of the larger ports on the Atlantic Seaboard, was not included on the air route. When that meeting was over they had scheduled a meeting of the Mayor's Aero Commission, just

such a body as we have here in Chicago. Before this Committee adjourned, they voted to ask the legislature for authority to bond the city of Baltimore for $1,500,000 for an air port. That was their reaction when they realized Baltimore was going to be left off the air line. Simply because Chicago is already on several air lines, we can't afford to be asleep to the possibilities that this new transportation method and its attendant industry have to offer.

It is sound business, and what is more, it is mighty good patriotism, because in the event of a national emergency we will need, first of all, the aircraft industry. The army and the navy will never support a real aircraft industry on peacetime orders. If we are going to have an industry equipped with an adequate competent engineering staff and production force, able to produce aircraft such as will be needed in an emergency, it is going to be because the industry in peace times is supported by the civilian demand for aircraft. Air transport will furnish our industry with the speediest means of transportation, and you know what you men suffered during the last war, when you had to fuss with priority certificates and heaven knows what, to get your stuff moved. If you had had a little air service to help out it would have been a great boon, and with your sport flying, with your lighted airways, with your terminal facilities, and an air-minded people, it is going to be a lot easier job to produce competent air pilots.

NEW LEGISLATION AFFECTING CALIFORNIA HIGHWAYS

(From "California Highways")

In making an investigation of the approved bills affecting state highway legislation, the Highway Commission finds that more measures of value to the development of the State Highway System were passed by the Legislature and approved by the Governor in the 1927 session than at any session of recent years.

The measures show that the Legislature desires to safeguard the investment in and insure the development of the State Highway System as well as to regulate its operation as a transportation system. However, without the broad understanding and encouragement rendered by Governor Young, some of the new legislation might not now be taking its place in the law books of California.

Some of the measures of most importance to the highway system are briefly described.

Senate Bill 3. This bill was introduced by Senator Breed of Oakland. It provides an additional one cent tax on gasoline, the proceeds to be used entirely for further construction on the State Highway System. This bill fulfills the aspirations of Highway Commissions since 1921, and carries out the recommendations of the Highway Investigating Committee. It places new highway construction on a permanently financed basis and provides a substantial annual revenue therefor. During the 79th and 80th fiscal years, the new tax should produce about $15,500,000.

Senate Bill 518 was also introduced by Senator Breed.

This legislation simplifies the Highway Commission's problems in allocating funds by classifying the highways in both northern and southern sections of the state. Long standing disagreements between sections as to the relative amount of highway expenditures are settled as the result of this legislation.

Senate Bills 708 and 709 were introduced by Senator Wagy of Bakersfield. These measures repeal the gross receipt tax on commercial vehicles and trucks as embodied in former legislation, which tax has proven impractical of collection. They substitute increased registration fees for commercial vehicles in lieu of the tax provisions of the repealed bills.

Senate Bill 864 was introduced by Senator Nelson of Eureka. This bill legalizes the Highways Commission's policy in widening state highways, by fixing a minimum width of 80 feet for state highway right of way. Obtaining wider rights of way has become a difficult part of our problems. The fixing of a legal minimum width of 80 feet will be of incalculable assistance.

Senate Bill 885 was introduced by Senator Fellom of San Francisco. This legislation recognizes the growing public dissatisfaction with the slow transportation afforded by ferries, and the commercial value of toll bridges. It directs the State Highway Commission to investigate the toll bridge situation and report to the next Legislature on a plan for taking over by the public of all toll bridges on the State Highway System. The matter to be investigated is whether such structures should be owned by the public and operated at public expense

or whether they should be built by private funds and paid for by the user in tolls which cover interests, repairs, depreciation and profits.

Senate Bill 847 was introduced by Senator Rush of Suisun. This bill recognizes an emergency and appropriates funds in the amount of $120,000 for the reconstruction of the Sacramento River bridge at Rio Vista, a lengthy structure, on a Legislative Act Road. Under the emergency appropriation, the bridge will be completed before revenue is available from the new gas tax.

Assembly bills of most interest to the highway organizations are as follows:

Assembly Bill 404 was introduced by Assemblyman Crittenden of Tracy. Its purpose is to clarify responsibility for the maintenance of irrigation structures on public highways.

It provides that those owning, maintaining and operating irrigation ditches requiring structures across the highway, must keep such structures in repair; however, when such structures are built in a permanent manner in accordance with the plans approved by the county officials, their mainteance afterwards shall devolve upon the county.

Assembly Bill 1175 was introduced by Assemblyman Noyes of Yuba City. This bill appropriates $200,000 for the construction of a causeway across the Sutter by-pass. This territory was divided several years ago by reclamation works under the control of the state. The appropriation provides for bridging the by-pass, and probably will be supplemented by Sutter and Yolo counties joining to improve the adjacent highway connections, thereby creating a short cut from Yuba City to Woodland.

Assembly Bill 1284 was introduced by Assemblyman McDonough of San Francisco. This provides $600,000 from the General Fund for the purpose of paying the wages of convicts employed in road construction camps. Wages of prisoners average about 30 per cent of the total highway construction expense of these camps, and the highway funds are supplemented to that extent.

The bill also provides that convicts, when so employed, shall not come under the provisions of the Workmen's Compensation, Insurance and Safety Act of 1917.

Assembly Bill 1292, introduced by Assemblyman Byrne of Los Angeles, authorizes the transfer of State Prison Board funds to Highway Commission funds in a sum not in excess of $100,000. This recognizes the justice of claims of the Highway Commission that prison appropriations for maintenance of convicts should be extended to prisoners employed in road camps. Highway funds devoted to prison road construction are supplemented to that extent by the measure.

Another enactment of great importance was Assembly Bill 1119, introduced by Assemblyman Feigenbaum of San Francisco. This bill creates a Department of Public Works, and creates a Highway Commission of five members as a division therein. Its purpose is the centralizing of all public works of the state under the jurisdiction of a director, who will serve as a member of the Governor's cabinet. From the administrative angle of the Governor and the Board of Control, responsibility is centralized under the new arrangement.

The most outstanding feature of the legislative policy was the absence of additions to the State Highway System. During the past few years, those interested in state highway matters have realized more and more that funds provided could never accomplish the completion and adequate mainteance of the state system unless its mileage was limited. An equitable division between the state and the various counties of responsibility for public highway construction and maintenance is necessary if state highway affairs are to be prosecuted in a business-like manner.

AIRCRAFT RESOURCES OF AMERICA

By J. Parker Van Zandt, Stout Air Services, Inc., Detroit, Mich.

(Paper read before Western Society of Engineers March 15, 1927.)

It is hard to realize in this day of modern aviation that only 25 years ago any one who really seriously believed that mankind would one day generally fly was supposed to be mentally unbalanced. The U. S. Patent Office actually classed all inventions with regard to human flight along with perpetual motion, and refused to issue any patents whatsoever on the subject. That was as late as 1903. There is a curious story about a young physics instructor at Yale University, who became interested in flying and built himself a machine, which he proposed to fly as a box kite. In this

machine he had an ingenious device for warping the wings, which was closely analogous to the ones the Wright brothers used with such success. But when the Yale University authorities learned of this activity on the part of their physics instructor, they informed him that he would either have to stop his experiments or sever his connection with the school. They informed him that the university could not afford to have its dignity lowered by being connected with any such ridiculous idea as human flight. That man is now a very well known and respected pioneer in the aeronautical fraternity. As late as 1901 a scientist with an international reputation, Sir Hiram Newcomb, proved to his own satisfaction by elaborate calculations that human flight in a heavier-than-air machine was a scientific impossibility. Then barely two years later two poor young proprietors of a bicycle shop in a Midwest town, with only a high school education, calmly proceeded, with utter indifference to the professor's feelings, to demonstrate the impossible.

On December 17, 1903, down on the sand dunes of Kitty Hawk, North Caroline, the Wright brothers started something the end of which is not yet in sight, and yet the world took very little notice of what they did. It was eight days before any New York paper even took the trouble to mention the fact, and then they did not find out the names of the inventors. Of what importance was it that two young chaps of no reputation should fly in a flimsy-looking, crazy machine, for something less than a minute, a matter of seconds, at a speed of thirty-odd miles an hour? And yet on that day, in December, 1903, they started something which, as Kipling said was the "Opening line of the opening verse of the chapter of endless possibilities." Or as a good engineer would put it, they were the first ones to discover how to make an asset out of overhead.

I wish there were time to compare the technical progress from that day, which is only a little less than 25 years ago, to this day. The engine that the Wright brothers used was 12 h. p. and weighed 14 lbs. per horse power. Today we have engines a thousand horsepower and more, which weigh close to one pound per horsepower, and they are vastly more reliable and more economical to use.

Began in Small Way

The Wright brothers were delighted to succeed in flying for less than a minute at thirty-odd miles an hour. Today the high speed record is over three hundred miles an hour. Planes have gone up 40,000 ft. in the air. They have stayed in the air over fifty hours without coming down to refuel. Our own U. S. army planes have flown around the world. A group of five of our army planes flew up to Nome, Alaska, and back without any accidents. The Atlantic Oceans has now been crossed—they cross it so often I am not quite sure how many times, but a few months ago it had been crossed eight times. An Italian has recently crossed it again. Of course, our own Commander Byrd has flown over the North Pole, and a dirigible has flown from Europe over the North Pole to the North American continent. About fifteen years ago the first transcontinental flight was made when Rogers flew a plane from the East coast to the West in something like two months, advertising a new soft drink. Three years ago Kelly and MacReady made a non-stop flight from New York to San Diego in a little over twenty hours. The following year one of our army officers flew from New York to San Francisco in one day, between dawn and dusk.

It is interesting to think of this transportation map of ours; as the Chairman has pointed out, transportation is the life blood of the nation. It is the thing by which business is measured, and its success is made possible. It is only a few score years ago when our continent was a tremendous distance across in terms of transportation. Measured by the transportation yardstick it took some sixty days to cross our continent, only seventy-five years ago, and the trip then was made partly by canal boat, partly by stage coaches and partly on horseback, and it was a difficult, dangerous trip, and fatiguing one.

Then came the railroad era, and with its perfection along about the first of this century, the distance, this 60 days, was cut down to about 90 hours. So that we have, instead of 60 days, three to four days, and the map is visibly shrinking, and the effect on business, of course, was tremendous.

Aviation Eliminates Distances

Now, however, we have a new transportation yard stick and the three or four days is reduced to 20 hours. So that, measured by the transportation yardstick of aircraft, we have a country that is 20 hours wide and 10 hours broad.

If one thinks what that is going to mean in business, he can see what tremendous possibilities are ahead of us when our transportation problems are reduced to a United States which is only 20 hours wide and 10 hours broad.

It is curious that we were slow in this country after the war to see these possibilities. Perhaps in Europe they were better educated by the war, which was so close to them, to what aircraft could do. The English and the French knew how reliable German aircraft were and the Germans knew how reliable the English aircraft were. So the spread of aircraft came first in Europe. The first air lines began between London and Paris, where they converted some of the army planes into passenger planes, very uncomfortable ones, but they carried a number of delegates across to the Versailles Peace Conference. Out of that military use for transportation purposes grew the great network of air lines in Europe, and today, one can travel from London to practically any capital in Europe over air lines on regular schedules, and run in a most reliable fashion—that is, most of them are running in a reliable fashion.

Lester Gardner, the editor of Aviation magazine, recently made an extremely interesting flight of some 35,000 miles, in which he flew in 70 or 80 different kinds of planes without any motor failure, without even a motor sputtering in the whole expedition, into Russia, down into Africa, and into Central Europe. It is extraordinary the number of things that have been carried by the planes in Europe. *Pate de fois gras* has been carried between the French cities to the various capitals of Europe. Racing horses have been carried across the channel in the big Handley Page planes, horses particularly subjected to sea-sickness; a bear has been brought to the zoo, a pedigreed bull has been carried, and an enormous number of curious things have gone by air. I remember on a flight to North Africa a part of the way I had to sit on a lot of automobile spare parts being carried to English motor cars in Morocco, and which otherwise would have delayed their owners weeks if they had been shipped by the regular channels.

Carries All Sorts of Freight

I remember my companion going down from Southern France to North Africa was a representative of a tailor, with samples of military uniforms for French officers stationed in Africa, and from Morocco to Algeria my fling companion was an Algerian wine merchant who had been over making arrangements for the sale of his product. They have gone straight from camels and donkeys to aircraft in Africa, without the intermediate step of railroads, and they are making use of it in a very interesting and complete way.

I remember a very curious incident that occurred at the Amsterdam air port one cold, rainy afternoon in September. A young English salesman was there, waiting for the plane to come in from Hamburg on the way to London. I was waiting for it, too, and I asked him why he did not go back to Amsterdam and get a cordial and get himself warmed up, instead of standing in the mist and rain, and then take the train to the Hook of Holland and have a comfortable night's sleep on the boat to the London estuary, and he'd be on time for the next London business day? He said, "You don't quite understand my case. My home is in London. I have lived there all my life. All my friends are there. I am a single man and my nights are very valuable." (Laughter.)

You find a lot of uses for aircraft that you don't anticipate when you sit down to add them up. I remember seeing some planes in London, Handley Pages, loaded with silver bars being transferred to the bank in Paris. Right after the war Cologne was cut off from the Germans by a cordon of French troops. English troops were in Cologne and French troops surrounding it. That was the time when the mark was sliding in value. The Germans wanted to get their money into Cologne to protect their currency. The French would not let them through. So they flew hundreds of millions of marks by air from Berlin to London, transferred them to a British plane and flew to Cologne. Thus they kept up their exchange rates in Cologne, until one day they had a forced landing and the French confiscated several billion marks, and that ended that.

Accept Changes Slowly

It is a curious thing about any new form of transportation that there are certain mental resistances that always crop up. If you want an interesting afternoon sometime, go into the library and look up the history of the growth of railroad transportation. It seems that every new transportation method meets with three objections. People first say the thing is impossible, that it can't be done. Then, when its possibility is proved without a

doubt, they claim it is impractical, it is too expensive, it is out of the question from a practical point of view. When its practicability is settled then they fall back on their final argument, that it is undesirable and unsocial, and altogether to be abhorred. You find these three objections hindering the growth of the railroads. The canal owners and the owners of the stage coach lines, in fact every one who had special concessions with the then existing transportation lines threw every imaginable barrier in the way of the growth of the railroads. Even the Post Office Department, which has covered itself with glory in the last few years in connection with aviation, at that time expressed official doubts as to the ability of the railroad to become useful agents in the carrying of mail, and they threatened to remand the mail contracts back to their former stage coach lines and not use the railroads any more.

In the United States we grew very slowly, indeed, while Europe was getting ahead under the artificial stimulus of these subsidies. A couple of years ago the situation looked very blue. Government officials were all more or less prejudiced against aviation. The story of the splendid work of the P. O. air mail had not yet received the publicity it so well merited. The army and navy officials frowned on military aviation. There was no legal status for aviation, no way of giving air mail contracts except on a directly competitive basis with boats and trains. In 1925 the Kelly Air Mail Act was finally passed. That opened the way for the air mail lines which have made a really marvelous record, and I am sure Secretary McCracken will tell you more of that in his address.

Now Recognized by Law

Last year the legislative cornerstone for the growth of commercial aviation in this country was laid with the passage of the Bingham-Parker Act. Today we have in Washington a group of splendid, experienced, enthusiastic, air-minded men, who are leading our aviation program forward, and doing it in a very splendid way, indeed. I would like to take this occasion to compliment our Secretary of Aeronautics for the splendid start he has made in the new Aeronautic Department, and for the fine things I know that are ahead of us. So that today, I think we can honestly say the year 1926 is truly the Year One in commercial aviation in America. We have just got our start now. We have had eight years of assimulation and consolidation since the war. We have had a chance to discover what Europe has done on government funds by subsides. We are going at it in a businesslike way, and I believe we are going to show Europe that after all, the country where aviation was born is not going to be always behind in this field.

It is a curious thing how few people really appreciate where we are today in aircraft operation. We have been running an air line over in the state of Michigan for the last eight months, a passenger air line, between Detroit and Grand Rapids, and you'de be amused at the extraordinary number of questions and discussions we have had with prospective passengers on that line, and the curious prejudices and misconceptions they have about flying. I sometimes think that the prevailing attitude of the public about flying is similar to the case of the man crossing a dark plain one night, who fell into a deserted mining shaft. As he fell he caught an old beam that lay across the mouth of the shaft and clung to it, hung there, kicking and pulling, but he could not get up, so he hung, sweating and praying until finally his muscles gave out and he fell to the bottom—six inches. A lot of our passengers finally screw up their courage to make a flight. They are either forced into it or they get somebody else to go up with them. They are simply bewildered to discover all their fear of it, all their ideas about it, came from preconceived, wrongly formed opinions, and that the actual thing itself is so entirely different.

Aviation Now Comparatively Safe

There is no such thing as absolute safety. Nothing is absolutely safe. I am willing to make the prediction confidently that travel by air will never be absolutely safe. Neither will travel by rail or travel by motor car nor by the elevated nor by the subway; any form of transportation involves a hazard. The whole question that the public wants to know is not, is it absolutely safe which they know is unattainable, but whether the advantages of this form of transportation obviously outweigh the hazards which it introduces. The railroad train was a thousand times more dangerous than the canal boat. Yet people don't travel by canal boats any more, and the aircraft, while it introduces a new form of hazard over any other form of transportation, at the same time gets away

from a lot of hazards which our present forms of transportation involve. When you get up in the air over a city and look down at the white ribbons of roads and see hundreds of dots darting by each other and know those are automobiles going past each other eighty miles an hour, each going forty, with a clearance of a few odd inches, you think what fools those people are to take such chances. Many of our passengers say that they never realized before how foolish it was to take such chances on the roads; they want to get up in the air where they have room to move.

A Town That Was Too Sure

There is a story which bears on the situation, I think, in connection with the problem that Chicago is faced with now, a municipal air port, which ought to be repeated. It is a true story, involving two cities in Pennsylvania, the city of Harrisburg and Columbia. I hope none of you come from Columbia. If you do I apologize in advance for what I am going to tell. In the old days the stage coach lines went from Philadelphia through the city of Columbia, a town about 40 miles south of Harrisburg, on the Susquehanna River. There they were ferried across to the other side of the river and went on into the Alleghenies. You remember they had cog wheel cars to go over the Alleghenies into Pittsburgh, and Dickens, when he came here, described his trip over the Alleghenies on this cog wheel line, and the extraordinary discomfort of it all. Columbia was one of those smug towns through which the axis of the earth sticks visibly out, and they were perfectly satisfied that the route to the west would always go through their city. There was no other place for it to go. Then came the era of railway expansion, in which so few people really had faith. They started to spread out, started their lines toward the west. As they got a little further along they wanted to expand, and put a headquarters on the Susquenhanna River, and Columbia was the logical place to put it. But the worthy Chamber of Commerce of the City of Columbia saw no reason to make any special inducements to the railroad to come there. A group of young men with vision in the little hamlet of Harrisburg, which I assume no one in Columbia had ever heard of at that time, had faith in what the railroads were going to mean to the country. They got together the citizens of their town and they said, "We have got to get this railroad up here," and they pledged to the railroad any support necessary to get them to put their headquarters there, and they made their offer so attractive that the railroad could not refuse, and as a result a terminal station of the Pennsylvania railroad is now at Harrisburg. Almost everybody in the country knows Harrisburg and has gone through it, but I wonder how many ever heard much of Columbia?

New Indutsry Needs Help

That same sort of thing is going to be repeated in the history of airplanes. Air travel is going to make new lines. It is going to make new traffic lanes and cities with vision are going to be the ones who get to it first and who benefit from it most. As a native son of Chicago I must say I have been disappointed in the practical results that Chicago has shown in attracting air transportation to it. Chicago has a lot of air lines here, but they have come to Chicago almost in spite of itself. I can say that in Chicago today we'd have a passenger air line between Detroit and this city if it had a satisfactory municipal air port convenient to the downtown business section. It has not and that line has gone elsewhere. And I doubt if a passenger air line will come to Chicago until they make it convenient for passengers to reach the downtown section from the terminal of the air port. You know, while we can fly anywhere that there is air, today we still have to come down, and we need parking facilities. Every transportation form needs terminal facilities.

The poor airplane is in the same situation with the motor car and the railroads. The rilroads have spent hundreds of millions of dollars correcting their failure to have foresight enough to provide suitable terminals when the opportunity was there.

I met a person in a city which I shall not name some time ago, who said to me, "This city of ours will never get ahead so long as it remains a city of windmills."

I said, "Windmills? What do you mean, windmills?"

"Why," he said, "don't you know what windmills are? Windmills are people who are full of air and go round and round but they never get off the ground."

Air Lines Making Money

Now, if you want to make Chicago air-minded you have to get up in the air.

There is no way to tell anybody what aviation is about unless you try it yourself. We have today planes that are remarkable for their comfort, for their safety, for their reliability. The Fokker three-engine plane is a beautiful plane. Byrd demonstrated its reliability in his flight to the North Pole and back. The Philadelphia Rapid Transit Company operated for four months between Philadelphia and Washington during the Sesquicentennial, and carried 3,692 passengers with absolute safety. The Vice-President of the Philadelphia Rapid Transit Company told me the other day that in his opinion they have demonstrated to their own satisfaction and to the satisfaction of any reasonable person who will study their records, that air transportation can be operated with multi-engined equipment of that character with sufficient safety, dependability and reliability to justify its operation anywhere. The whole job now is not the technical problem. It is the commercial problem. It is how to operate it profitably. Mr. Stout has said, there is a great difference between a commercial plane and a military plane. A military plane has to support itself in the air, but a commercial plane has to support itself commercially, financially, as well as aerodynamically, and the great problem now is to find a means to apply all this accumulated technical experience in a profitable way. We have a tremendous amount of accumulated technical experience. There have been 50,000,000 miles flown since the war on regular scheduled air lines, carrying passengers or mail or goods throughout the world. Over a quarter of a million passengers have been carried on those lines and thousands of tons of mail and goods. There are a few lines that are making money today. There is one line down in Central America, Columbia, which paid 10% dividends every year until last year, when they paid 12%. There is a line out west, due to a very favorable mail contract, is doing very well financially. There are other lines that are supporting themselves.

I wish for Chicago that every one in this room and every other leader of thought in Chicago would get up for himself in a modern plane and find out for himself what can be done today in the way of air transportation. As soon as you do that you won't need any more speakers on the platform telling you what aviation is about. You will know yourself, and you will be the very best advertisement that aviation could want. We find on our air line between Detroit and Grand Rapids that our very best boosters, our very best sales agents, are the men who have made a flight. They go out urging their friends to take a flight, too. Chicago ought to get this air port on the lake front or convenient to its downtown business district at the earliest possible moment, and not until then can it expect to take its rightful place in the aeronautical sun.

FLOOD CONTROL

By E. E. Blake, Chairman Interstate Commission Control of Arkansas and Red Rivers.

(Address delivered at A. A. E. Convention held in Tulsa, Okla., June, 1927.)

Things engineering are like things sectarian—largely projected imagination applied to unimaginative facts.

Your slogan, "Get an engineer—get the facts," is good; your wives have so learned. But with the engineer you get his prejudices—man's most dangerous enemy—and his fear of the engineer you did not get, and the public prejudices. And others beside politicians have well-tuned ears.

In the combat between "Levees only" and no more levees, the beans have been spilled and the real solution unsought and unformed.

Had California been discovered first, New England would yet be unsettled; had the Mississippi been settled from the top down, there would have been no levees, or very slight ones. But the control of the Mississippi having started backwards we have crayfished on it ever since. The contractors have told Congress what to do and, being uninformed, Congress did it. Now Congress is being informed that there are just as good contracts above as there are below, and the work below has failed six times in fifteen years, the last failure as it nears completion, surpassing.

Had the work been done above, instead of below, the failure of one unit would not affect the others. If we ever complete the levee system, just think what would happen. It is no longer an academic discussion.

A conference on flood control is of general, and not local, importance. We take it that temporizing with localities and local remedies has amply proven its futility. We have searched the press of all types; the Nation is told in every

place and every form that leveeing the lower Mississippi is no longer to be tolerated. We are convinced that special arguments will no longer control Congress against the "folks back home." The whole nation is clamoring for an upper control as well as a lower control.

Oklahoma, years ago, set about to determine its practicability. We became involved in flood control study as the chairman of a committee of the Chamber of Commerce of Oklahoma City, seeking protection against flood loss by the North Canadian River, and soon discovered that local efforts would be expensive and futile; and, since many interstate streams converge in Oklahoma, it involved interstate and national relations and cooperations. It is a matter of interstate law as well as engineering. We reached two conclusions and two questions.

First Conclusion: We have more water all the way down the tributaries of the Mississippi than we have prepared for, with promise of increasing heights of flood in the future.

Second Conclusion: We have taxed and neglected the greater population and the greater property on the intermediate reaches in the false protection, and false promise of protection of the lower reaches.

Question 1: Shall we have less water or more levees? We have just been through the South; they want something else besides levees, and they want less water. We have been through the middle section; they want less water and no levees. We have been around the top; they want more water and no more levees.

Question 2: How can we please them all?

We, therefore, through the intervention of former Governor M. E. Trapp, of Oklahoma, set about organizing an Interstate Commission of nine states to study and control the flood problems of the Arkansas and Red River basins from the mountains to the Gulf and bring about interstate and national cooperation for their protection. We found levees not practicable and that river straightening was a criminal error. It therefore became a matter of cutting down flood flow instead of fighting its apex.

At the Governor's solicitation, commissioners were appointed from the states affected, Colorado, New Mexico, Kansas, Texas, Oklahoma, Arkansas, Alabama, Mississippi, and Louisiana, and after several meetings, arrived at a form of compact, or agreement, under authority of the Constitution of the United States, Article I, Section 10, for the control jointly with the Federal Government, of these two basins. To this work more than a hundred able engineers contributed the plan, and the lawyers contributed an acceptable form of compact which may be of general use and which compact has since been signed by four states and ratified by two states of New Mexico and Oklahoma, and is almost sure to be ratified by the special session of the Texas legislature where it is now pending.

The plan gives promise of efficiency for the Arkansas and Red River basins, and the same plan, of course, can be applied to any other tributaries or to the whole Mississippi until the whole Mississippi is reduced to a state of harmlessness, not alone in the Delta region, but throughout its whole course.

We have maps and plans and estimates to support our claim.

Our plan divides itself naturally into

I. The Engineering feature;
II. The Administrative feature;
III. The Financial feature;
IV. The effect, or general economic result.

I. Engineering Feature

Treat major stream basins as a unit, from the Gulf to the source, such as the Red River basin, the Arkansas basin, the Missouri basin, the upper Mississippi basin, the Ohio basin, etc.

(a) Reduce the flood flow by conservation of one-third the flood run-off by reservoirs consistently and comprehensively distributed among the headwater tributaries sufficient to keep the flood flow of the main stream within the channel capacity, which we have found averaged two-thirds of the flood flow. We determined that the destructive part of the flood was from twenty to forty per cent thereof, or about an average of 33 per cent of the flood flow. West of the Mississippi, there is no lack of economical natural basins. We did not exhaust the reservoir possibilities by any means.

(b) All reservoirs are designed:

1. For permanent impoundage of a small percentage of their capacity for the local social benefit.
2. For temporary impoundage of such safe percentage of their capacity as may be utilized locally, or diverted into permanent storage for local use;

3. Adequate percentage for mere retardation of excessive flood flows to be periodically expected.

(c) Protection of unusually low bottom lands along the reaches of the stream between the Delta area and the mountain area with flowage capacity equal to the designed channel capacity, with factor of safety.

(d) Reduction of the flood flow in the controlled tributaries above the reservoir by miniature reservoirs to cut down silting.

(e) Maintenance of the Delta levee system now constructed, or at such adequate standard as the reduction of the flood flow above to protect the upper valleys makes necessary to protect the Delta area.

(f) Overlapping effects below the confluence at the Mississippi of two or more controlled major tributaries to be given appropriate proportionate consideration.

In developing this plan, we located, surveyed and estimated west of Arkansas and in the Arkansas basin, about 200 possible reservoirs in Oklahoma, Texas, New Mexico and Colorado (and projected from topographic maps, about 30 in Kansas) holding about eight million acre feet, at an average cost below $10 per acre foot in Oklahoma and Kansas; retaining all the mountain head waters in New Mexico for use in New Mexico and Texas, at an average of $12 per acre foot; retaining all the head waters of the Arkansas in Colorado for use in Colorado and Kansas at an average of about $20 per acre foot; retaining all of the waters of the Grand and Illinois and other rivers for building up navigation; one-third of the flood flow from all remaining drainage area to prevent flood destruction in the valleys and reduce flood heights below.

This development will reduce the Arkansas more than one-third of its flow at and above Little Rock, save southern Arkansas and Louisiana; would have reduced the 1916 and 1927 Mississippi flood crests below the confluence of the Arkansas from 3 to 5 feet, and would reduce the average Mississippi flood crest 2 to 4 feet; to insure stages of water from 6 to 9 feet in the Arkansas from some point in Oklahoma to the Mississippi, thus insuring navigation all the year around.

On the Red River, we figured on about 100 reservoirs costing about the same rate, and reducing the Red River to its bank capacity above the Delta and two-thirds of its flood stage at Alexandria; reducing the Mississippi flood crest about one foot, protecting western Louisiana and promising navigation as far as Texarkana, or if greater storage be built, probably to north of Dallas or Fort Worth. Already over 500,000 acre feet of permanent storage for use in Texas is installed on the Wichita tributary, completely controlling it.

Dams designed follow the Miami River plan of earth and rock fill, with 3 to 1 rip-rapped upper face and 20-foot crown, 2 to 1 lower face with drainage core, concrete water core, discharge boxes, spillways. We challenge criticism of this work and the estimate of the cost. All these reservoirs can be reduced if necessary, in most cases increased in capacity without material change of cost, or may be multiplied in number. There are advocates of 10,000 or more small ones which would serve the purpose, suit the country better, but would cost more per acre foot.

II. Organization Scheme

(a) Compact between the nation and the states, including any part of the benefited area, ratified by Congress, create a single conservancy benefit district as extensive as the drainage basin constituting an interstate municipality for its specific purpose;

(b) Such municipality to be administered by an interstate commission composed of constituent state commissions (4 Red River; 8 Arkansas basin; 5 Missouri basin, etc.) and a Commissioner for the Federal Government for each district, all constituting an Interstate Commission for each basin district, or, if Congress will grasp the entire situation, then a single Interstate Commission constituted of the National Commissioner and a commissioner from each state participating. This commission to expire when Congress votes to take control of the administration of the districts so formed.

(c-1) Such Interstate Commission to determine the extent of control necessary in each basin by conservation of waters necessary for the protection of the valley areas above the Delta region, and so far as economical for each particular basin to reduce the floods from that basin upon the Delta areas; and necessarily to determine the economic balance of control between control by conservation and the control by levee.

(c-2) To contract for and construct and maintain the approved work, and

to maintain control of the release operation after construction; to determine the extent to which controlled waters may be utilized without impinging the flood control purpose.

(c-3) To determine the gross cost and gross extent of benefit to the protected basins, and then the proportionate extent of benefit to the Federal Government and to the area to each state within the basin, and to determine the ratios of benefit between the Federal Government and the state areas to the gross benefit and allocate to the Nation and to each State its equitable quota of charge.

(d-1) Each State to accept its State quota and, unless it votes to discharge it as a State obligation, then by appropriate laws provide that its Commission shall determine the benefit to the State, its protected municipalities and properties within that State, and distribute the quota to the benefited within the State in proportion to benefits, and collect the same, all comformable to the laws of that State; a State to have police control of the works within the State, exclusive of maintenance, repair and release control not inconsistent with the general purpose of flood protection.

(d-2) Each State to have the right to provide for and control the utilization, not repugnant to the general purpose of flood protection, and conformable to the laws of the State, of the controlled waters within its boundaries.

III. Financial Scheme

(a) Congress to provide in its ratification enactment for assuming a part of the benefits for the protection of the Federal function, such as interstate commerce, mails, military movements, navigation, etc., as may be allotted to it by the Interstate Commission, or as may be accepted by Congress, and to provide for the payment thereof as may be determined by Congress.

(b) As to the States' quota, follow the established practice of benefit special assessment districts, as near as may be, and conformable to the laws of each State as to the component area and quota within that State. Each State to accept its allotment of benefits and costs as determined by the Interstate Commission and provide for the payment thereof; or by law provide for the distribution to the benefited municipalities and properties within that State by the Commission from that State, or such other provision of the law as it sees fit to make.

(Application: In developing the control of the Arkansas, as above suggested, we figured its cost at about $75,000,000, so we fixed the cost at $100,000,000. The cost of the Red River control figured at $36,000,000, so we fixed the cost at $50,000,000.)

In presenting this matter to Congress and the War Department, and the Department of Commerce and the Interior Department at Washington last spring, we found the opinion to be that, on such work-out, Congress would willingly assume 50 per cent of such cost. Congress appropriated moneys to cooperate in the final surveys, available now. Considering that Congress now pays 60 per cent of the cost of levees and all of the cost of navigation (which would be reduced by such control) considering the national effect of such comprehensive workout on the Mississippi, I have no doubt Congress would assume 60 to 66 per cent of the cost. Assuming that it assumes 60 per cent, then on the Arkansas the remaining 40 per cent would be distributed to the eight States composing it, and the remaining 40 per cent of the Red River control to the four States composing it, or both could more conveniently and with equal economy, be incorporated in one district. Necessarily, some States would benefit more than others, as, for example, Oklahoma and Louisiana would receive greater benefit than New Mexico and Colorado, but the allotment of quota to each State should not be difficult.

On the above assumption on the Arkansas, there would be $40,000,000 to be distributed to eight States, or an average of $5,000,000 each. The State would find it most economical to provide for the entire payment of this by some small excise tax, or other tax, or assuming that it accepts one-fourth, or $1,250,000 providing for the payment of one-tenth thereof each year for ten years, or one-twentieth thereof each year for twenty years, the burden would not be felt. In Oklahoma it would be far less than the interest on the State property lost each year. The other $3,750,000 could be distributed conformable to the laws of the State to the benefited municipalities, corporations and private properties, the only difficulty being that the clerical work would probably exceed the amount of the principal.

Federal Function: As to the Federal functions, such control increases the safety of railways, highways and bridges, lessens bridge costs and both cheapens bridging and allows more bridges, there-

by insuring commerce, mails and military movement.

Navigation: Such enormous quantities of storage over such a wide area as the Arkansas, the Red, or any other river basin, promises consistent stream flows. Considering that all of the uncontrolled flow, and two-thirds of the flood flows are free to pass, but would be retarded in their departure, it is conceivable that sufficient of the impounded flow can be released under intelligent central control so that all the converged flows will build up a flow of probably 8,000 to 10,000 second feet on the Arkansas and 4,000 to 5,000 second feet on the Red. I think also on the Missouri, but that is not my problem.

Considering that all the western branches of the Arkansas converge in eastern Oklahoma and just above Fort Smith, it is easily conceivable that the flow of that river may be regulated to maintain such flow to Fort Smith or Muskogee, or possibly Tulsa. The Mississippi River Commission reports show that 8,000 second feet gives a 12-foot mean depth and a 20-foot maximum at Little Rock. In the development of the Arkansas basin, we kept this point in view, and such flow can be maintained throughout the year from the impoundage contemplated above the Arkansas line, without impairing flood protection, and this certainly means navigability.

We have one proposed reservoir, adequately fed, which will furnish 6,000 cubic feet every second in the year and, if held for navigation purposes alone, would maintain, with the uncontrolled flow, a navigable stage on the Arkansas River, below into the State of Oklahoma, equal to the low water navigation of the Ohio with its hundred million dollars expended for locks.

The same consideration on the Red might develop its navigation to Texarkana, or above, maybe to north of Dallas and Fort Worth. In any event, it will be interesting to see an effort to keep water in a river instead of paying to dredge sand out, and run the water out. An hundred years of accepted river engineering has brought us to a decided disappointment both on navigation and protective works. Let's work at the other end a while. We can do no worse than the engineers have done.

Our economists figure that this would benefit the agricultural part of the drainage basin $20,000,000 per year, exclusive of all benefits of flood control. That, as an economic factor, it would represent a benefit of $200,000,000 and that in commercial turn-over it would mean an increase of $500,000,000 per annum, and this should interest the ears of the bankers and business men attending this conference, from commercial cities.

Under such circumstances, the coal, lime, timber, zinc, lead, cement and other cheap-moving commodities of the basin would find ready market in the great commercial centers of Pittsburgh, Chicago, Detroit and Cleveland, New Orleans, and St. Louis, where as now they do not get out at all. Such a regulated river would not require locks, dams, or so much extensive repeated channel dredging or improvement, as it would not be subject to the changes of bed or dangers of a stream which at one time is a raging torrent, and at another time a succession of pools and riffles.

Stopping Abuses

The increasing flood crests below are accounted for by the increased rapidity with which the water finds its channel, and down its channel. For this there are many causes, increased ditching, highways, city streets, etc.

One great abuse has been overlooked, that is the upper stream flood fighters are obsessed with the idea that straightening streams will speed the water past them and save them. It looks plausible, and its plausibility is the working capital of many so-called engineers. Oklahoma has had its full share of such devastating work. Such a cut does lower the flood crests at the cut and immediately above, for one flood or two, providing the floods are not too big and stay within the banks, but the stair-step in the gradient eats back, increasing the gradient for a long distance, producing high velocity beyond the stability of the bank, and the specific gravity of the bed of the stream; the bed goes out to find a less ferocious current, and is replaced with heavier sands; the banks slip in and go lower, to find a bed at the first flatter gradient below, together they form a dam, checking the floods, building back, obstructing the flow, and the subsequent floods sweep the valley to complete ruin.

For example: The Canadian River near Oklahoma City has been shortened over 20 miles in 60 miles of distance. It has raised its bed 8 feet and widened itself in places as much as ten times. It is twenty-five times as expensive to bridge as it was; and a formerly moder-

ately high water of slow progress is now a destructive flood that goes down with a velocity never before known. For instance, in one measured distance where in nature a flood crest required 14 days to pass 190 miles of river in 26 miles of distance, it now passes down the 40 miles of straightened river in 22 hours, but leaves nothing behind it. The river straightening engineer should be put in a straight jacket with the "levees only" engineer and both sunk in the sands. Of course the channel cutter above has brought grief to the levee engineer below, and is one of the elements that he probably left out of his equation at the start; the cutter will continue to cut and can only be stopped by reducing the streams at the source and giving no excuse for such criminals to prey upon the credulity of the farmer.

In our country, head flows move down the western high gradients with great velocity. The tail of a flood overtakes the head of a flood, the flood lens constantly shortens and increases in convexity as it approaches the flatter beds, there to flatten, and west of Arkansas they are roaring, tumbling torrents, sweeping the valleys, cutting the banks, moving the bed, destroying every structure which they can reach. Below there, the get-away is slow and they fill up and widen. They evade or destroy the artificial confinement and spread over great areas of flat-lying lands. We have measured and weighed the beds of streams and find that in some cases the bed of the stream has moved down the river 200 miles in ten years, which is conclusive evidence of an increased velocity, over that in a state of nature.

This must be stopped or, in time, the heavier sands will flow down and will fill up the flatter channels of the streams and our rivers will be destroyed and they will be practically as wide as the valleys. Measurements prove this and these moving sands are so heavy that no elevation of levee will be able to promote a current that will carry them on. Reservoirs, therefore, properly distributed, will reduce these floods, reduce the velocity to the stability of the bank and river bed, flatten out the flood lens, stop erosion and bed movement, cut down the silt, stop channel filling, reduce the cost of bridging and road elevation, save farms, crop and stock, at least 800 miles farther up the Arkansas and the Red than the levees can, and will hold off from the leveed sections the quick volumes and high crests that will later surely spell their destruction. It requires no engineer to see this.

Irrigation, Fish, and Fun

The western tributaries of the Mississippi rise where they need water worse than anything else, unless it is religion, and where they have more farm land than they have farm relief.

The first objection one hears to reservoirs is that they occupy too much good land. We did not find it so. Probably four-fifths of the area of the sites aggregating 350,000 acres in Oklahoma and probably 50,000 acres in New Mexico and Colorado, are not now cultivated. We figured the land cost, in the estimates given; most of it, if under water, would produce more and be more valuable than now, and each reservoir would be of great economic benefit to its locality. In such reservoirs, the lower contours are designed for constant water; the intermediate contours flooded occasionally, and the upper contours rarely. Permanent water out there is worth $75 an acre for fish production, and irrigation capacity is worth $100 per acre foot, and that is more than it is worth for farming. Camp sites around the border of the permanent water would sell for more than enough to buy the basin, so there is neither land nor economic loss.

It is often said that the same reservoir cannot be used for flood control and irrigation, or power; that the asset of flood control is an empty reservoir, and the asset of irrigation or power is a full reservoir. This is not true. The same capacity, of course, cannot be used for both, but this has been considered and hundreds of reservoir possibilities can be economically developed so that a sufficient part of the capacity is dedicated to each purpose.

Economics

The Arkansas and the Red River control contemplates holding sufficient water without impinging flood control for irrigation of more than a million acres of now arid, or semi-arid, lands in New Mexico, Texas, Kansas, Colorado, and Oklahoma, which can easily produce $40,000,000 worth of crops per year, so the plan does not waste land.

In any event, we would not flood any more lands than the broken levees have done; and we would not have to rescue a half million refugees, or call on the Red Cross.

Climate and Sociology

What effect such quantities of water would have on the weather, we do not know. We do not recommend it. However, we do know that everywhere the American people hunt bodies of water in "the good old summer time"; that near water life is more endurable in this climate; pleasures are more varied; comfort more possible; that we drive a Ford a thousand miles to the lakes; the boys and girls, the men, women and the dog play hookey to get to the creek if there be water therein; that we have too much water for us and the South part of the time and not nearly enough for us the balance of the time; that our surplus at one time is our necessity at another, and is a destructive enemy of the South every time. That so much money must be, and will be, spent on the rivers, and we feel that it should be spent to benefit the most people in the most ways, and not as heretofore, to disappoint a few.

Electrical Power

Visions of vast electrical power accompany every thought of impounding water. Only a few reservoir sites promise commercial power. Some might, however, provide a small amount of intermittent power for the villages of local farm use, but they could probably not compete with coal, gas, and oil in that land of such abundant stored treasure. If electricity could be developed, that, of course, would only be an added resource.

The control of the Arkansas basin, as worked out by the Interstate Commission, contemplates a storage and retardation from the flood flows of probably fourteen million acre feet west of Little Rock, and on the Red River probably six million acre feet west of Alexandria. The two rivers show the approximate relation to each other that 3 bears to 5. Colorado developed about 300,000 acre feet of permanent storage; New Mexico 800,000 acre feet permanent, and 400,000 temporary, or flood control; Kansas 1,650,000 acre feet; Oklahoma about 10,000,000 acre feet, and the balance in north Texas, western Arkansas, and northwestern Louisiana.

This, of course, would differ with the mind of the man who last had worked upon it. In this area, the rainfall, flood flow and flood lens bear substantial similarity, but the area is so vast that storms have never covered the whole area. A coordinated control of release, therefore, over so vast an area from the central control point ought to be very effective.

The highest contribution of the Arkansas to the Mississippi flood since 1912 has been 31 per cent (1916) and the lowest 3½ per cent (1913) and the average 17½ per cent. My guess on the 1927 flood was 35 per cent.

The Red River is very much smaller, but combined, as they did this year, carries devastation to the South. If you think this is too much money, go down and look at the South.

I am confident that, had such controls been in, Arkansas and western Louisiana would have been saved this year. Ordinarily one would be afraid to hazard an opinion on this, but, in the light of conditions, one is encouraged to think that an off-hand opinion is approximately as good as scientific ascertainment.

It should, by this time, be accepted that protective works against the Mississippi must be as comprehensive as the water enemy to be fought. Heretofore, we have exerted every effort to concentrate the water, and entirely miscalculate the extent of concentration.

As it is, the long soaked levees are dissolving. What it would be if they were higher and heavier and the flood crest kept up higher on them, we leave it to others to conjecture. The laws of nature cannot be defied, even by the greatest of engineers, and mud walls will not hold water under very high pressure. Therefore, a levee limit exists. Economically also, in protective benefits the levee limit is extremely limited, compared to the tremendous flood losses on the streams above them. Not being an engineer, I have no hesitancy in expressing an opinion that, in the light of past experience, the levees have already exceeded their practicable elevation.

It is necessary now to begin to cut down the floods, both to save that which has been done and to prevent a repetition of disasters and protect a great amount of property, people and the greater interest of the nation above.

Someone dismissed the reservoir idea by the quaint remark, "Reservoirs would help if they knew where to put them." The answer is, put them just below where the water falls. We had no trouble in doing this.

No estimates are available, but we are free to guess that the crest of the Mississippi flood can be reduced 5 feet much cheaper than the levees can be raised to meet a 5-foot higher rise, and we know no reason why the southern people should oppose this idea.

Another view is that economically the losses from flood do not fall alone on the person whose property is destroyed, but affecting everybody finally, and the higher sugar, cotton and other products of the South, to the rest of the United States is to pay for the damage wrought there this year. So the North should support it.

We are not original nor alone in this idea. Europe has practiced it on many rivers for more than a century. Old King Min of Egypt, according to Herodotus, started it 30,000 years ago. The Miami River people have proved it in Ohio; Sacramento and Los Angeles River people in California. The War Department has developed the idea on the Tennessee to increase the electrical output of Muscle Shoals and engaged in the study of the Potomac for power purposes alone. If we can afford it for one purpose on those streams, we can surely afford it for all purposes on the Mississippi.

The Mississippi is the Nation's greatest asset. It has been turned into a great and expensive liability. The theorists of fifty years, who could not be argued out of their impregnable official position, are confounded with a demonstration of their error.

The alleged contention of economy is overbalanced by stupendous losses. The people of thirty-one upper States have been taxed to ruin four or five lower States, while their own (upper) greater losses have been ignored. The Nation is aroused at its devastation. The Congress that longer localizes the remedy, at the expense of the whole country, will only last a short term.

Those who pay in money and those who pay in grief now together demand relief for both, and demand that asininity and pigheadedness be both abandoned; that all means of control be utilized instead of one, and that all benefits be obtained instead of few. No matter what the cost, it can never equal the expensive past; and even if it costs more in money, it will cost less in tombstones and in tears; it will not only preserve the production below, but make for production above. The glorious insignia of the castle should no longer be trailed in the slime of manufactured overflow; that profession should assert its best effort in the interest of humanity and national economy, rather than to again pedestal its toppled idol, which has crushed so many in its fall.

MINNESOTA HAS LONGEST CONCRETE ROAD

The longest continuous stretch of concrete roadway in the world has just been completed between White Bear and Duluth, Minn. This pavement passes through 29 towns and villages over its 137 mile length.

Paving construction on this thoroughfare, State Trunk Highway No. 1, was begun in 1923. Highway authorities point out that the completed highway will save a great deal of money through low maintenance costs. Maintenance costs for gravel surfacing on this highway have been as much as $3,000 a mile, state highway records show.

This Minnesota pavement is two miles longer than the concrete pavement extending from Olympia to Vancouver, Wash. The third longest length of concrete rural pavement reaches from Kansas City to a point west of Columbia, Mo., a distance of 125 miles.

CREAMERY WASTES

The Iowa Engineering Experiment Station has recently published bulletins No. 81 and No. 82, dealing with the treatment of creamery wastes. No. 81, a 30-page bulletin by Max Levine, Geo. W. Burke and Clair S. Linton, deals with the purification of skim milk solutions on a lath filter and No. 82, a 32-page bulletin by Max Levine and Lulu Soppeland, deals with the proteolysis by bacteria isolated from creamery wastes. These bulletins are the third and fourth of a series published as a result of investigations conducted for the last several years.

THE FREE BRIDGE

"Men of all countries, of all ranks, of all states, foreigners or citizens, pilgrims or merchants, whether on foot or on horseback, whether poor or rich, whether with carriages, or with horses loaded or unloaded, or with other animals, or in whatever manner they travel, can by virtue of our concession, without being held by any toll, pass freely over this bridge."

So reads the charter authorizing the construction of the bridge at Tours built in the eleventh century by the Count Eudes "in order to be useful to posterity and consequently agreeable to God."